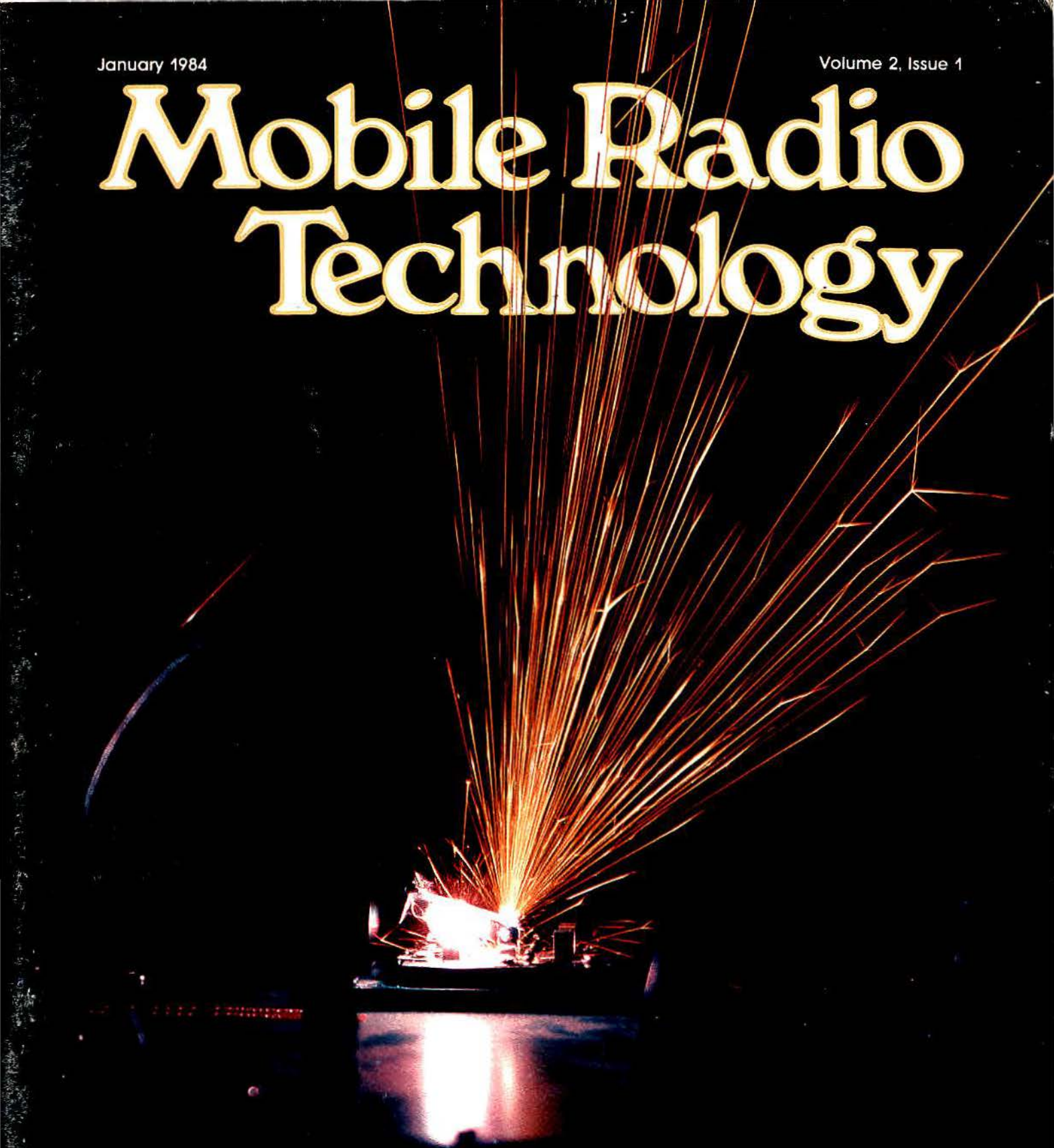
January 1984

Volume 2, Issue 1

Mobile Radio Technology



'Zap-Proof' DC Converter

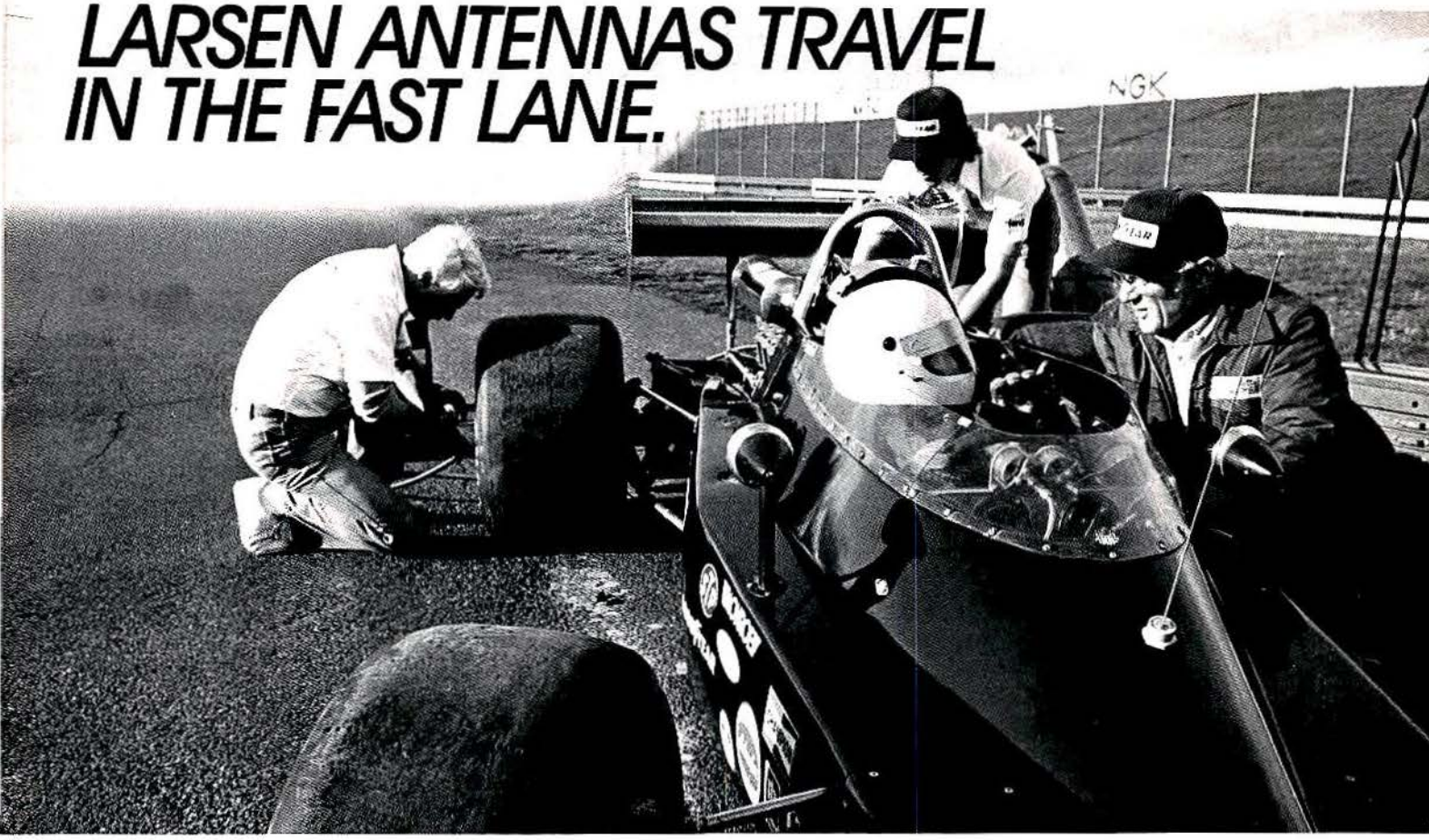
Intermod Control, Part 5

Increasing Cellular Frequency Reuse

Repeater Interference Cancellers

Spectrum Farming

LARSEN ANTENNAS TRAVEL IN THE FAST LANE.



Race car communications demand the best from an antenna under some of the worst conditions. Split second decisions require reliable signals at exceptionally high speeds. That's why Larsen Antennas are used on race cars at the Indy 500. Because Larsen Antennas are designed to take high speed with minimal signal distortion. Proving they can travel in the fast lane without putting a drag on their performance. Larsen's precision tapered stainless steel whip provides maximum flexibility while minimizing radiation pattern distortion, giving you a clear consistent signal. And Larsen's exclusive Kūlrod® plating, gives your antenna high conductivity to assure that maximum power goes into communicating — not heat. That full measure of performance goes into our service too. With prompt delivery, personal attention and a no nonsense warranty that won't slow you down.

Our full line of antennas will handle almost any application. If not, we'll custom build one for the job. Either way you win.

So, whether your antennas race around a track or around the clock. Larsen Antennas will keep you ahead of the situation, with dependable performance. We'd be glad to show you how Larsen Antennas will work for you. Write for our free full line catalog.

Larsen Antennas

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Toll Free order line 1-800-426-1656
In Washington State 1-800-562-1747

IN CANADA: Canadian Larsen Electronics, Ltd.
283 E. 11th Avenue, Unit 101
Vancouver, B.C. V5T 2C4 Phone 604-872-8517

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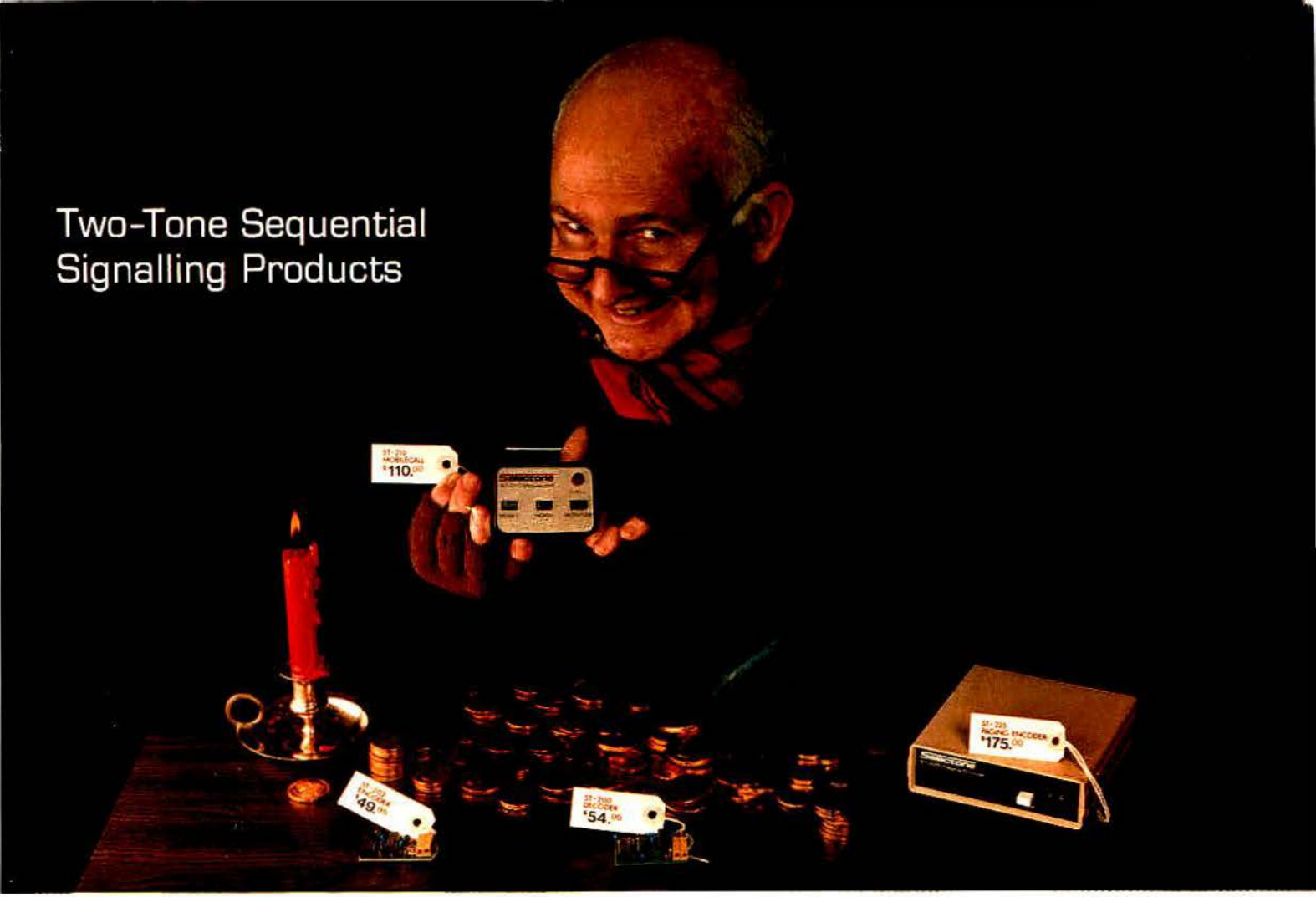
Reader Service No. 1



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To cope with today's economy, there has to be a little "penny-pincher" in every communications expert. And, when you can combine quality, compatibility, ease of maintenance and versatility at competitive prices in one product line; you've got a sure winner. Selectone's full line of Two-Tone Sequential signalling products does just that, and more.

SELECTONE LOWERS THE COST of this low-cost selective calling system even more by providing continuously tunable frequency setting without the need to purchase and inventory special reeds or tuning elements.

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If versatile, compatible, and penny-wise communications is your goal, call us toll free at (800) 227-0376 for full facts on Selectone's comprehensive line of 2-way radio signalling products.

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***Service station net, quantity 1-9.**

Reader Service No. 2

COVER: A shower of sparks accompanies the closing of a switch to send a 3000 volt spike to the input of a DC-to-DC converter designed by Wilmore Electronics. See Christopher Ely's article on page 23.

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Mobile Radio Technology

Volume 2, Issue 1 January, 1984

CONTENTS

NEW!

NEW CONCEPT
NEW VERSATILITY

MULTI-MODE DTMF ENCODER

FEATURES:

- Illuminated Manual Keypad with Selectable 90ms Burst
- ANI on PTT or Key command
- Functions Digit before or after ANI
- Station and Mobile Installations

APPLICATIONS:

- Interconnect
- Remote Control
- Selective Calling

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publisher's note

. . .a manufacturers association? A good idea! Now, the next step. . .

At the November *Communications Marketing Conference*, a group of manufacturers met and formed the nucleus of what could become the first true association of manufacturers in the land mobile industry. Tentatively named the *Association of Communications Equipment Manufacturers (ACEM)*, this association is, we think, an idea whose time has come.

For years, manufacturers have been the primary source of income for industry trade shows and have financed the lobbying efforts of most of the land mobile user associations. And yet, due primarily to a lack of unity, they have had little influence over which, where, why and with what frequency trade shows are held. Nor have they had any significant influence on the regulations that govern their futures.

The *ACEM* is a significant first step towards changing that situation and it could provide many other benefits for manufacturers and the industry they serve. For example, some of the projects and activities proposed at the meeting were:

- coordination of major trade shows.
- formation of "co-op" export trading companies.
- sales representative referral services.
- technical lending library coordination.
- coordination of regional technician clinics.
- group purchasing of incentive programs, liability insurance, etc.
- "manufacturers only" training conferences.

If approved by the *Communications Marketing Association (CMA)*, the *ACEM* will become a section of the *CMA*.

But. . .the important point is *not* the name, specific projects, or organizational details. The important point is the simple fact that *an association is being formed!* The specifics are, as of now, only the proposals of the 20 some companies who attended the meeting. Manufacturers who join now will each play a major role in what this association will do and how it will be organized.

So, the next step is not for prospective members to question or quibble over the specifics. The next step is for manufacturers to join and help build an organization that will allow them to, as a group, express their views and take action on industry problems.

We strongly recommend that manufacturers at least investigate the potential benefits of this association by calling the *CMA* Executive Secretary, Bud Rebedeau at (312) 577-8350 or any member of the *ACEM* membership committee: Larry Kline, *Antenna Specialists;* Walt Ullrich. *Multiplier;* Lynne Camp, *Centurion* or Ray Collins, *Telewave*.

Phil Cook, Publisher

ICOM UHF

Above and Beyond the Competition

IC-435

UHF MOBILE
2 Channel / 35 Watts

ICOM brings you the IC-435...a 35 watt, 100% duty cycle, 2 channel, synthesized UHF mobile transciever in an incredibly compact package.

The IC-435 covers 450 — 470 MHz in two 10 MHz ranges. It features a noise cancelling microphone, 2.5 or 5 KHz diode programmable steps, multiple tone encoder (optional), LED channel readout, an advanced preset squelch design, and 5 watts of receiver audio.

All of these features come in a slim package that is only 2"H x 6-9/16"W x 11"D and...the front control panel can be remote mounted.

Other optional signalling features and/or a smart compatible version are available.

For more details contact ICOM America, Inc. or your local ICOM dealer.

IC-U12

UHF HANDHELD
12 Channel / 3 Watts

As a companion to the IC-435 or as a stand alone UHF transceiver, the IC-U12 is the perfect handheld. Available in 450 — 460 or 460—470 MHz versions, the IC-U12 is the smallest, most compact 12 channel UHF handheld anywhere.

The U12 features synthesized programming of standard and splinter channels (power adjustable to 2 watts), diode programming, and a heavy duty CM5 quick (1.5 hr) charge battery pack. The CM30 drop-in charger is required.

The IC-U12 is rugged, reliable, and is built using ICOM's proven handheld design. Included with the U12 is a rechargeable battery, a flexible antenna, and a belt clip. Interchangeable accessories, signalling options and slide-on battery packs complement the ICOM handheld line and are compatible with both UHF and VHF models.

ICOM

With ICOM, the business at hand is quality.

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2112—116th Avenue NE, Bellevue, WA 98004, (206) 454-8155

Reader Service No. 5

editorial

Technology—Weapon or Tool?

Here it is . . . **1984** . . . the year George Orwell's novel picked for technology to get out of hand forcing mankind to forfeit certain human rights. 'Big brother' had a communications system that enabled him to monitor and control virtually every human function.

Technology has made advances, but they have tended to *improve* rather than *reduce* the quality of human life. The target benefactors of technological advancements have shifted somewhat dramatically—away from the military/space/government sector toward the common man/consumer.

This shift is healthy, as long as it does not become total in its effect. The consumer does represent a tempting marketplace. The huge numbers of the consumer market are more exciting to product planners and R & D allocators than the same old space/military business sources. Potential rewards are even more enticing. But dollars spent now on reducing costs to match consumer ability (or willingness) to pay can ultimately benefit the big spenders by giving more and better capabilities to more people for fewer bucks.

Real high-technology blockbusters have been relatively scarce in the recent past, but reviving of yesteryear's ideas has shown increasing potential for expanding communications penetration into society.

In this issue, for example, the idea of *adaptive antennas* as 'interference cancellers' is resurrected . . . not because of any new breakthrough in their technology, but because another technology has advanced to the point where their value increases. Adaptive antennas emerged from military attempts to reduce the effects of intentional jamming, and now—calling the culprit *co-channel interference* (unintentional, of course!), the interference reduction technique finds a new problem to solve.

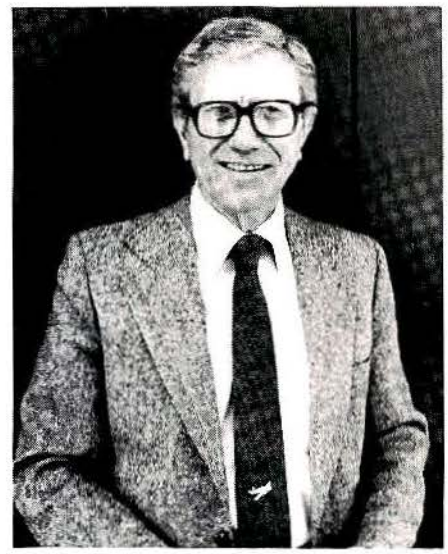
In another corner of this month's ***MRT*** is the announcement that ACSB (another 'old' idea) has earned renewed attention as a result of 'new' circumstances . . . spectrum overcrowding due to inevitable increased demand.

In yet another item, another solution is proposed—less Federal regulation—greater dependence on self-regulation . . . like an amplifier with both fixed and self bias, the former to preclude catastrophic system failures and the latter to minimize effects of unpredictable, often uncontrollable input/output problems.

The key seems to be the ever-improving harmony between (and interdependence of) regulation and technology. Although dedicated primarily to technology, we decided to include a new department in ***MRT, Regulating Technology***, the purpose of which is to mention (but not dwell on!) regulation developments as they impact technology.

Thus, one of the inputs to the operating bias circuit has made its influence felt. We yielded to several readers' letters bemoaning the sparcity of regulatory news in ***MRT*** . . . one writer saying that if ***MRT*** only had more regulation information, he'd really only have to read one magazine. After all, what good is feedback, positive or negative, unless it has a beneficial effect on the over-all operation of the system.

There are magazines that claim to be

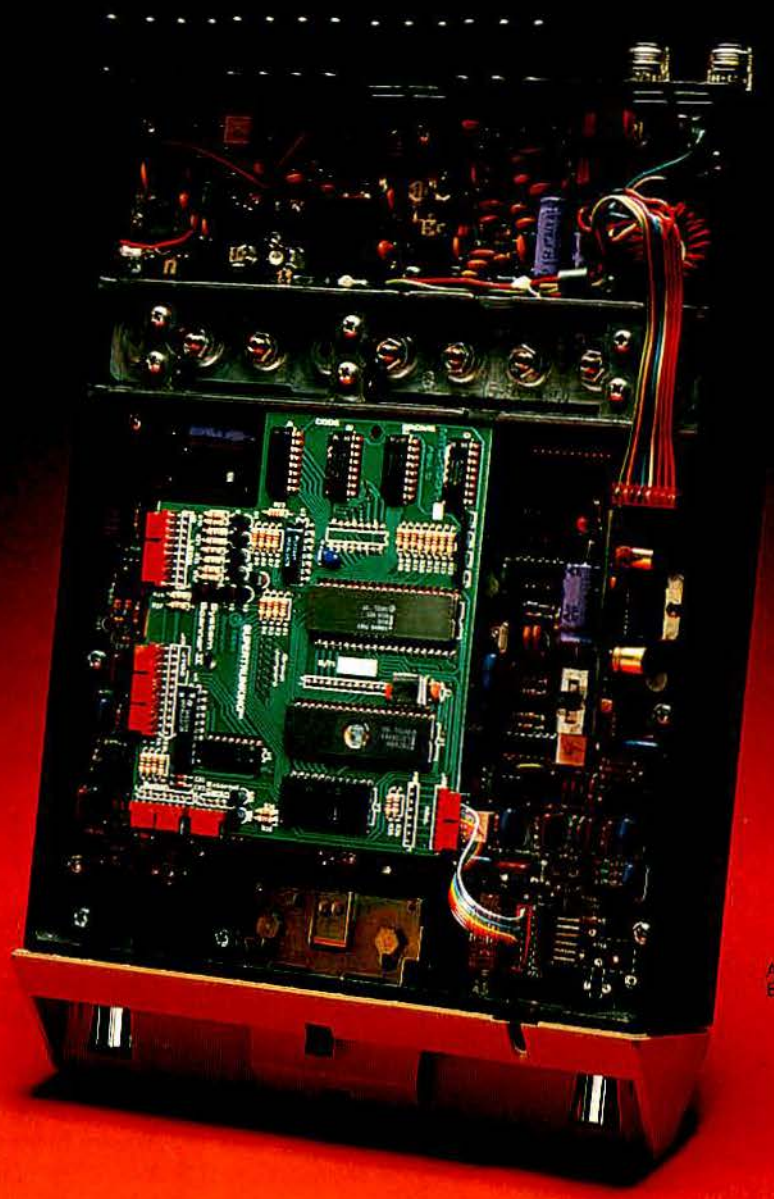


'complete' magazines that cover *everything* related to our industry. If we ran as much material on marketing, selling, regulating, promoting, operating, managing, and other aspects of the business as we do on technology (which we have accepted as our primary responsibility), we'd self-destruct in microseconds.

Most of the comments we receive reflect enthusiastic approval of our concentration on technology. Those that disagree by no means go unheeded—their contribution to our operating bias circuit is finite, but small by virtue of their number. Their effect may be negligible, unlike our appreciation for them.

So . . . **1984** . . . technology is still under control and tending to work for man, rather than vice versa. Instead of using technology as a weapon, government has fortunately elected to use it as a tool . . . a tool for building a better future for the people that government represents. JDF

Win with SUPERTRUNKING™



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E. F. Johnson Company

The SUPERTRUNKING™ Board
for both LTR 8700 and 8800 Series Radios

• Automatic Out-Of-Range Retry With Ringback • "Handsfree" Operation In Mobile Units • Built-In Horn Blowing Capability • Automatic Lock-On To System Within Range • Built-In Call Light Capability • Call Received Verification To Dispatcher • Extended Selective Call • Extended Sub-Group (Up To 40 Groups) • Scans All Systems For Incoming Calls • Automatic Transmit On "Call Received" Channel • Automatic Ringback If Channel Is Busy (Queing) • Continued Trunking Capability If Home Channel Fails

ADDITIONAL FEATURES FOR LTR 8700: Supports Eight Systems • Ten Sub-Groups Per System • 600 Channel Bandwidth • Extended Sub-Group (Up To 80 Groups)

Use the **SUPERTRUNKING™** Board in both single and multiple system applications. Its use in the LTR mobiles will enhance their operation and give you many advantages over the competitive products.

More Hi-Tech Communication Products On The Way

SCORPION SYSTEMS, INC. 217 North Madison Avenue, Los Angeles, California 90004 (213) 383-0033
Reader Service No. 6

feedback

Dear Phil:

In your September, 1983 issue of ***Mobile Radio Technology***, you featured an article written by Milt Friedberg on disguised mobile antennas. On page 58 of this article, there is a picture of Sti-Co's oval base Ford antenna which was not identified as our product.

Since we are the only manufacturer with this base, and in fact used this photograph with our new product release, I believe it should have been clearly identified as a Sti-Co antenna. The other antennas pictured are identified as Larsen's and Antenna Specialists' so I am sure that the omission of credit was an error and was not done intentionally.

We would appreciate it, however, if you would give us credit in a furture issue.

Antoinette P. Kaiser, President
Sti-Co Industries, Inc.
Buffalo, New York

The error of omission was mine (not Milt's). Thanks for the correction! —Don Bishop.

Dear ***MRT***,

Thanks for your recent published articles like "CTCSS Scanner for Repeater Control," "Predicting, Measuring and Reducing Interference Of Intermodulation Symptoms," and "Cellular Systems For Small Communities." Being a self-employed telecommunications technician working in the Central American and Caribbean Sea, I was very surprised to find such useful information in a two-way mobile communications magazine!

I already sent photocopies to friends in Sydney, Australia, where I used to work with British telecommunications companies. I like the "freshman's style" of your technical articles—where unnecessary math, calculus and science functions are avoided!

Today I would like to ask you to obtain the complete postal address of ABCOM Engineering and Independent Electronics in Rancho Cucamonga, California, for additional information concerning the CTCSS scanning controller technique.

Would it be possible to qualify perhaps for a subsciption to ***MRT***? Thanks in advance for your further attention.

Manfred Hoffman
San Jose, Costa Rica
Central America

Dear Phil,

Our students of today are so very fortunate to be endowed with your journal, which is available with such a vast value of electronic communication.

My first experience in this art started in 1911, when the industry was remote to spark transmitters.

Your editorial in the October 1983 issue should create sparks and inquisitiveness. All readers should be impressed with an industry that offers so much.

A good technically trained person makes a better salesman. We applaud you for your efforts to reach those who are coming up.

Jack R. Poppele
Tele-Measurements Incorporated
Clifton, New Jersey

Dear Sirs:

Please find enclosed our check no. 204 in the amount of $25.00 in payment of your invoice number 624. This refers to the ad placed by Bergen County Search and Rescue (a division of our organization) in ***Mobile Radio Technology***.

An additional note: The ad worked! We were able to locate the equipment we were looking for based on a reader response within the first week of our ad being placed. Please continue the excellent work of your magazine!

Gregg K. Danzer, Secretary
North Jersey REACT
River Edge, New Jersey

Dear Phil,

Thank you very much for your responsiveness in forwarding your mailing list to our agent in Las Vegas during our rather untimely experience. Without your help, properly informing the industry of our trouble and immediate action being taken to overcome that trouble would have been impossible.

Enclosed you'll find what appears to be the only "returned/undeliverables" we received back. From these returns, one can only presume that your list is incredibly clean. . . one of the cleanest in the entire trade publishing industry.

Frankly, your publication has made true fans out of everyone involved with Wilson Electronics. It is timely, topical and certainly views radio technology from an interesting perspective.

Again, thank you for your consideration.

Chris French, Advertising Manager
Wilson Electronics Incorporated
P.S. If this sounds like an endorsement, it probably is.

Dear Phil:

Congratulations and condolences on your candidacy for the board of the Radio Club of America.

Congratulations because it is an honor you deserve. . . condolences because it's a thankless task.

You got my vote.

Henry B. Kreer, President
Stevens, Kirkland, Kreer Inc.
Chicago

When we decided to make Model 3000 an even better value, there was only one way to go. The price was already much less than instruments with comparable capabilities. So we had to add more features.

With Model 3000B, you not only get a CRT display that shows modulation and carrier shift—it's now a Lissajous scope for a real-time picture of changing frequencies. And the scope can be either AC or DC coupled so you can either eliminate carrier shift or read it off the screen.

We've given the 100 watt powermeter a second range, 10 watts full scale, for finer resolution on low-power transceivers.

And our new automatic test system means you'll receive printed documentation of how your service monitor performed before it left the factory.

Of course some parts of the Model 3000 were too good to change: The 4-digit counter still displays frequency error with 10 Hz resolution (1 Hz optional), and shows sub-audible tones with 0.1 Hz resolution. Our exclusive "Sig Strength" feature lets you monitor and display both modulation and relative field strength simultaneously. And 5 kHz markers show the peak amplitude of your modulation at a glance.

But here's the best news: With all those improvements, the Model 3000B still weighs just 25 pounds, and still costs far below its competition. Just $7350. The more things change, the more they stay the same.

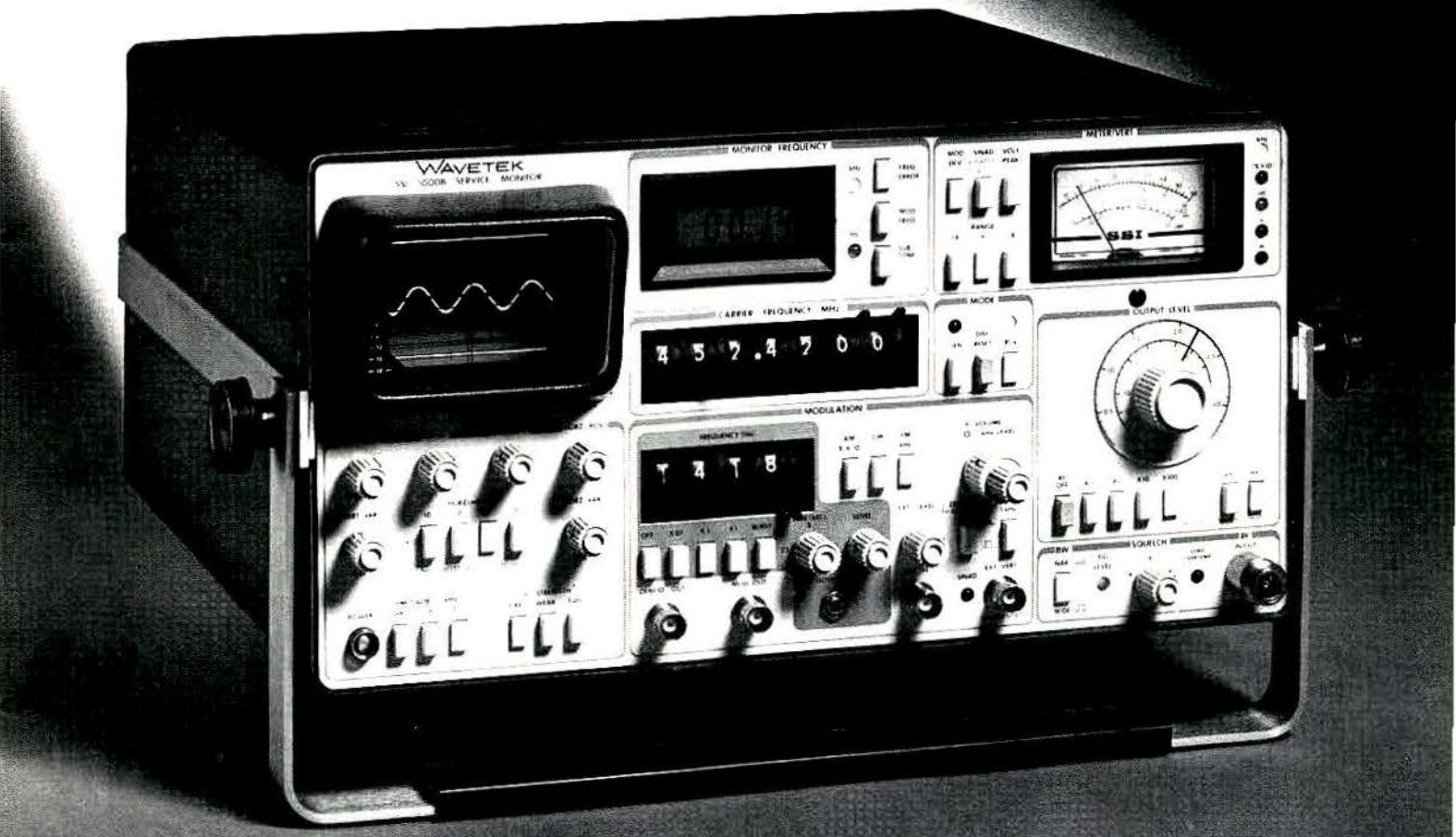
For a free demonstration, call the sales representative nearest you. For details contact Wavetek/SSI, 5808 Churchman, P.O. Box 190, Beech Grove, IN 46107. Phone toll-free (800) 428-4424. TWX: 810-341-3226.

Reader Service No. 7 **for Literature**

Reader Service No. 8 **for Demonstration**

WAVETEK

Model 3000 was the best service monitor in its price range.



Until Model 3000B came along.

news

Regency Announces Consolidation

Regency Electronics, Inc., has announced a merger of the formerly autonomous subsidiary organizations of Regency Communications, Inc., and Wilson Electronics Incorporated into a single entity, Regency Land Mobile, Inc. The announcement was made by Joseph E. Boone, president, Regency Electronics, Inc.

According to Boone, the consolidation will, "perpetuate two firmly established brand names, Wilson and Regency. In addition, the move will give Regency Land Mobile, Inc., a very strong ranking among land mobile radio competitors and the base on which even greater success can be realized."

Effective January 1, 1984, all domestic land mobile radio sales, marketing and product management activities will be centered in Las Vegas, Nevada, with manufacturing, engineering and international sales operating from Satellite Beach, Florida.

In anticipation of greater production demands as a result of the new consolidation, Regency has undertaken the development of an additional 100,000 sq. ft. manufacturing facility at the Florida location. The operation will be under the direction of Charles A. Merriman, vice president of manufacturing and general manager of the Florida group.

Operating from a new 42,000 sq. ft. facility in Las Vegas, Regency Land Mobile, Inc., formerly Wilson Electronics Incorporated, will be under the direction of Tyler Bryant, vice president of marketing and general manager of the Las Vegas group.

Manufacturer Holds CAD Conference

System designers, software suppliers and customers attended a computer aided dispatch (CAD) conference held in November by Kustom Quality Electronics of Lenexa, Kansas. The manufacturer sought suggestions from customers regarding changes to its line of mobile data terminals.

The company also expressed a desire to coordinate its hardware manufacturing with systems and software designers to ensure compatibility. Information was given by Kustom's president about the company's renewed financial strength, its quality control program, and commitment to the communications equipment market.

President Lyle P. Phillips outlined the company's turnaround, and announced that audited financial figures for the publicly held company would show Kustom once again on a sound footing. Phillips described some difficult times encountered by Kustom when it pursued the avionics market, and observed, "Communications is our horse." The executive said there were days when suppliers wouldn't call on Kustom because, "we couldn't pay them, anyway."

"When I saw the sign in the lobby that said, 'vendors seen by appointment only,' I knew we had succeeded in restoring supplier confidence," Phillips said. "Now they *want* to call on us!"

Finding the avionics market to be limited and the police radar market to be stabilized, limited to replacement of existing equipment, Phillips has led Kustom back to what he called its niche in communications. "At one time, we had $8 million to $12 million in communications," he observed.

Phillips credited the company's quality control program which included all production employees and the efforts of a new management team he advanced from within the company with the turnaround.

Kustom's director of engineering, John Kusek, demonstrated some modifications made to the company's mobile digital terminal. The display had been discontinued by its original manufacturer, and efforts to find a replacement have involved some extensive research and testing.

The result is a nearly direct substitution which will require retooling only the sun visor molding to accommodate a full eight-line display.

Among those attending the conference were representatives from three CAD systems and software suppliers and seven of the mobile terminal manufacturer's law enforcement agency customers who make extensive use of computer aided dispatch. A representative of a shipping port container handling company also attended to learn about digital terminal applications for material handling.

Dick Spingler, Kustom's system sales manager, said the company is reevaluating its position in the data communication marketplace as a direct result of the conference. Development of additional hardware and improved systems capabilities are being considered as part of the evaluation.

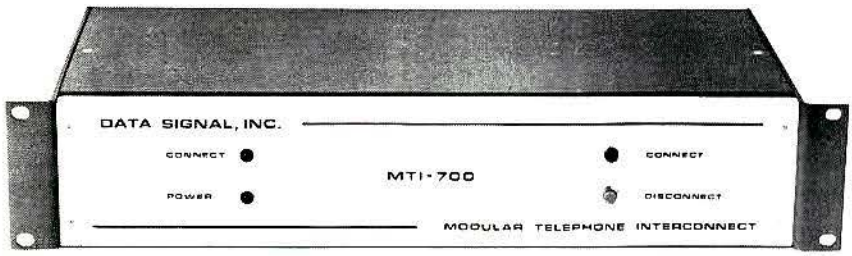
Spingler also said he hopes to formulate an adequate means of disseminating and exchanging user experiences with the MCT 10 mobile terminal to help customers share valuable information about specific applications.

IEE, Entelec Call For Papers

The IEE international conference, "Mobile Radio Systems and Techniques," and the Energy Telecommunications and Electrical Association '84 conference have issued a call for papers. One-page synopses are due at the IEE office, Savoy Place, London WC2R OBL, U.K., by January 16, 1984. Entelec paper abstracts are to be sent by February 1, 1984, to P.O. Box 795038, Dallas, TX 75379.

SOMETHING NEW!!
From the Leader in Product Innovation

UNIVERSAL TELEPHONE INTERCONNECT

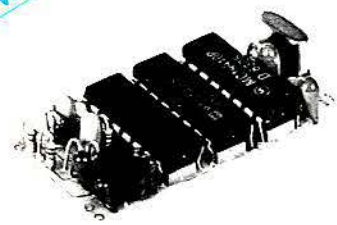


AND TELEPHONE LINE SELECTOR

Selectively call mobiles with DTMF, 2-Tone, or 2805 Hz decoders from DTMF or Rotary telephone lines with the Data Signal MTI-700 Modular Telephone Interconnect. Compatible with all full, half and simplex radio systems, the MTI-700 allows you to start with basic interconnect and add options as your needs increase. Options include DTMF regeneration, dial pulse conversion, long distance inhibit, multi-digit access, automatic ANI, and much more.

The MLS-280 Multi-Line Selector provides multiple telephone lines for your MTI-700. Each user has an assigned line for incoming and outgoing lines; no overdial operation required. Each MLS-280 can accommodate up to 8 lines, with a maximum of 256 lines.

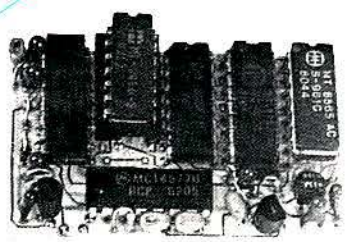
NEW



SUBMINIATURE ANI ENCODER

The smallest ANI available (the size of a quarter), the ANI-309 is ideal for hand-held or mobile radios with severe space limitations. Generates 2 ANI sequences of 1 to 16 digits. Encodes standard DTMF digits.

NEW



SUBMINIATURE DTMF DECODER

The MTD-200 is smaller than any decoder on the market and accepts transmission of all 16 DTMF digits. Ideal for hand-helds with severe space limitations, the MTD-200 functions by decoding a user specified code.

NEW

SPEAKER MICROPHONE

Ruggedly built, the Data Coder 11 encoder microphone has a built-in nominal 24 ohm speaker. Compatible with any transceiver, the Data Coder 11 and the rest of the Data Coder line of microphones combine up-to-date CMOS circuitry with snap-action keyboards.

NEW

BACKLIT MOBILE ENCODER

The MTE-3BL has a unique backlit keypad that makes night-time use easy. A transmit ready light illuminates when the transmitter is keyed and ready to send DTMF digits. An interdigit timer keeps the transmitter keyed during encoding process. The MTE-3BL offers ANI option.

DATA SIGNAL, INC.

2403 COMMERCE LANE • ALBANY, GEORGIA 31708 • TELEPHONE 912-883-4703

Reader Service No. 9

Jacksonville Is Site Of GE/NTI Cellular Demo

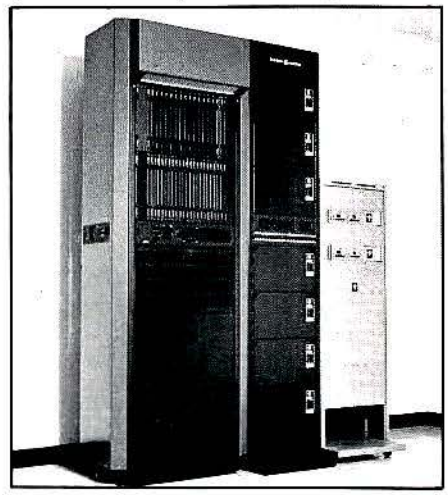
A model cellular radio facility operated by Gencom is used by partners General Electric and Northern Telecom to test and demonstrate its now type accepted equipment in Jacksonville, Florida.

The $2.5 million system is a small version of systems the partnership expects to provide as turnkey installations in 10 of the first 30 metropolitan cellular markets and in below-30 markets.

The Jacksonville system of three cells and about 100 in-car units was constructed to demonstrate the advantages of joint GE and NTI technologies. The switching equipment, said NTI vice president Edmund F. Tagg, "is designed to be out-of-service no more than 2 hours in 40 years of service."

FCC type acceptance of the GE-Star mobile telephone was announced in Jacksonville by Walter Weyler, GE vice president and general manager of the mobile communications division, during a system demonstration. He said that during the first two weeks after approval was granted Oct. 10, "we've written well in excess of $10 million worth of orders for delivery in 1984."

Touring the test installation are (l to r) Richard Callahan, president of NewVector Communications, Inc., Walter Weyler, GE vice president and general manager of the mobile communications division, Jack Hurley, GE cellular marketing manager, and Edmund Tagg, vice president of NTI's carrier network group.



Northern Telcom cell site controller is part of the cellular telephone test system now operational in Jacksonville, Florida.

Weyler said GE plans to introduce a battery powered, pocket sized unit in the fall of 1984.

GE and NTI officials said the partnership of the two companies in the cellular arena avoided needless duplication of each others' technologies. NTI, said Weyler, "has installed digital switches throughout the world which today serve 6,000,000 equivalent lines. That's more than any other supplier in the world."

Meanwhile, "GE is the world leader in 800 MHz trunked radio technology," Weyler said, "having installed over 2000 channels in the U.S.—more than any other supplier."

NTI intends to be a major supplier of cellular products and services, using its

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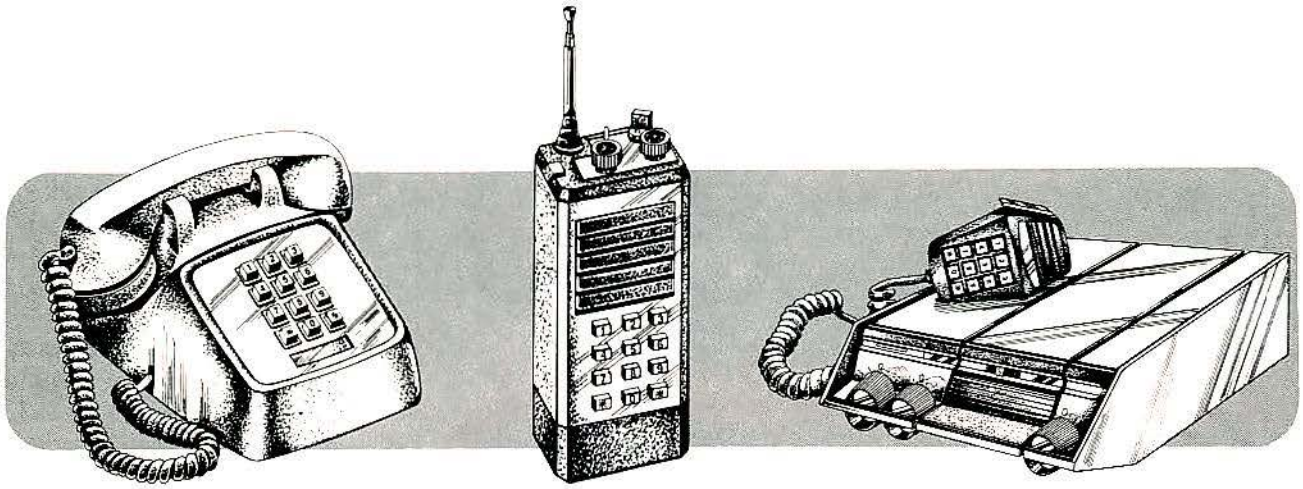

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wide range of digital switching and transmission products, Tagg indicated. Speaking about what NTI brings to the partnership, the vice president said the cellular system is built on NTI's digital multiplex system (DMS) switch line.

Proven DMS installations use the product of hundreds of man years of software development, "giving us the advantage of being able to overlay the cellular software onto existing systems," said Tagg. The result is the ability to quickly bring up cellular mobile systems on the installed base of existing product.

"The cooperative venture with GE is a sign of both companies' ability to react and adapt to the changing market developments," Tagg said.

Digital switching equipment at the Jacksonville, Florida, cellular test site is seen behind a map of coverage provided by three cell site transmitters.

FCC Seizes Marine Radios

U.S. marshalls, in a coordinated effort with FCC engineers from Atlanta, seized 53 radio transmitters from an Alabama marine radio dealer. S.E.E., Inc., a dealer in Bayou La Batre, Alabama, was suspected of supplying marine radios for illegal ship radio usage in the coastal areas of the Gulf of Mexico. Seized as evidence under search warrants issued by a federal magistrate, the radios were valued at $39,000.

The crackdown on illegal marine radio activity involves operation of the radios on frequencies assigned to police and fire departments, mobile telephones and other users.

Logan Sales To Rep TAD America

Logan Sales of Santa Clara, California, has been appointed TAD America's manufacturer for northern California and northern Nevada.

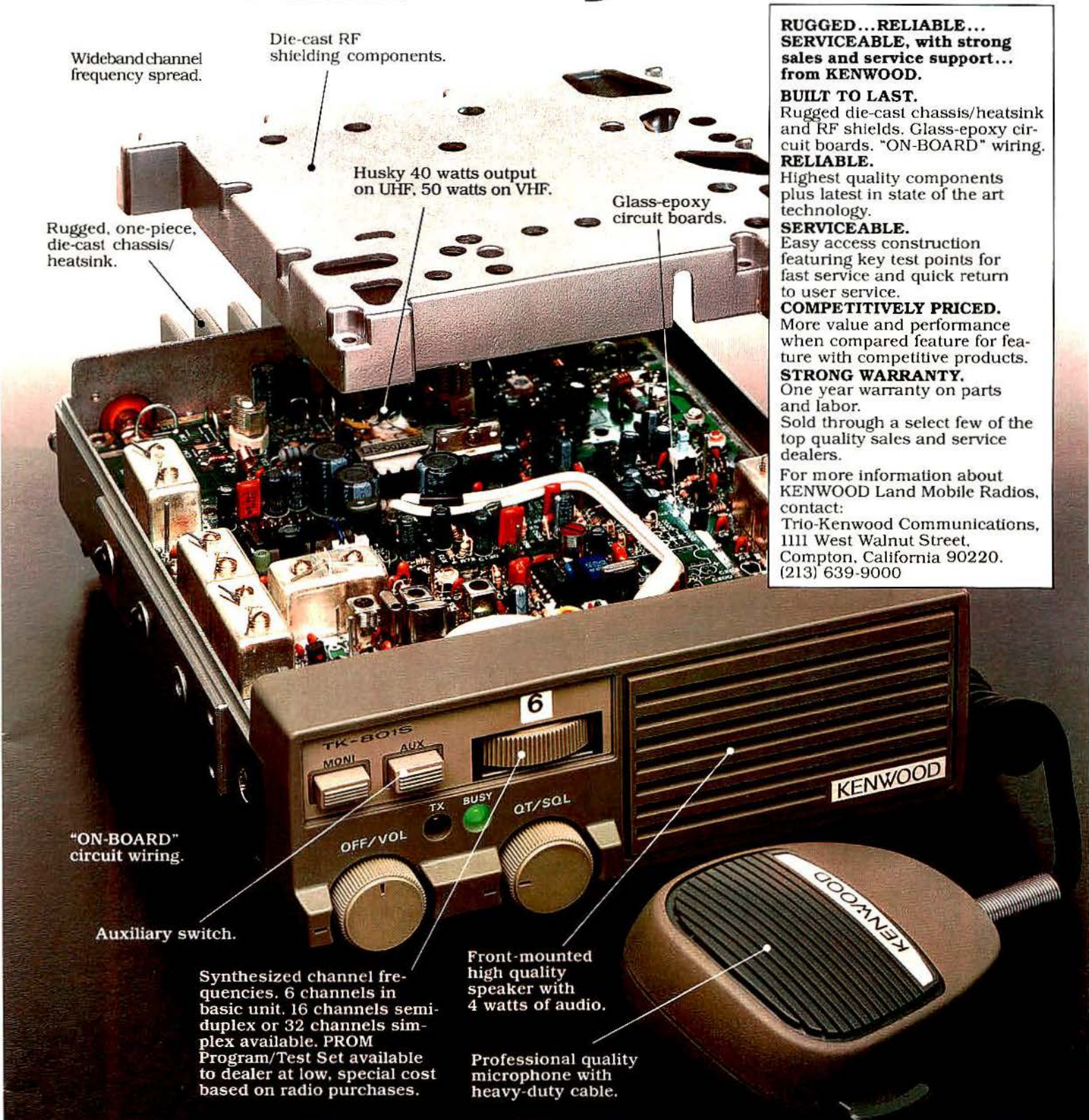
Glenarye Reports Earnings Increase

Earnings for 1983 increased 33% on a 22% revenue increase for Glenayre Electronics Ltd. of Vancouver, Canada. The September 30, 1983 figures showed a Canadian sales increase of 11% and an export sales increase of 29%. Communications products sales increased 40%.

Knight-Ridder Acquires SMRS

Knight-Ridder has received FCC approval to acquire 50% of TelAir Network Miami. According to the two companies, Knight-Ridder intends to acquire a 50% interest in TelAir's 14 other specialized mobile radio systems throughout the country.

The real story's inside!



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LAND MOBILE RADIO

NYNEX Mobile Communications Signs Agents For NY, NJ

NYNEX Mobile Communications Company (formerly Advanced Mobile Phone Service, Inc., Northeast Region), cellular subsidiary of the NYNEX Corporation, has signed Potamkin Cadillac, Henry Brothers Electronics and the New York Cellular Telephone Corporation as agents to sell new mobile cellular products and services in the New York metropolitan area.

Industry Forms Manufacturers Association

A new manufacturers association was formed during the annual Communications Marketing Conference in November. The group will be known as the Association of Communications Equipment Manufacturers (ACEM) pending approval of the name by the membership.

Activities of the trade alliance are to include public relations, industry data collection, training and education for market segments and trade show coordination.

Larry Kline of The Antenna Specialists Co., Walter Ullrich of Multiplier Industries, Lynne Camp of Centurion International and Ray Collins of Telewave formed a committee charged with responsibility for start-up details and membership expansion. Gregg Marshall of TAD America, Randy Friedberg of Antenna, Incorporated and John Ehret of TPL Communications formed a committee to review projects recommended by manufacturers.

Reach Common Stock Offer

Reach, Inc., a Nebraska corporation organized in February 1984 to develop a nationwide paging, data distribution and message network to transmit point-to-point personal contact information by means of FM radio subcarrier signals, will offer three million shares of its common stock to the public subject to effectiveness of registration with the Securities and Exchange Commission.

Bell Canada Signs For NTI Cellular Radio Equipment

Bell Canada has signed a contract with Northern Telecom for switching and control equipment to be used in cellular mobile telephone service. Northern Telecom will also supply equipment manufactured by General Electric under the agreement, valued at $5 million.

Pace Seeks Distributors For Cordless Telephones

The Pace Communications cordless telephone distributor program is "based on solid project margins for both the distributor and dealer, outstanding factory support and 'clean' distribution," said Pace sales vice president Jim Reynolds in announcing that the company is seeking qualified distributors.

The cordless telephone manufacturer, based in Harbor City, California, offers support activities, protected profit margins, assigned distributor territories and a private label program.

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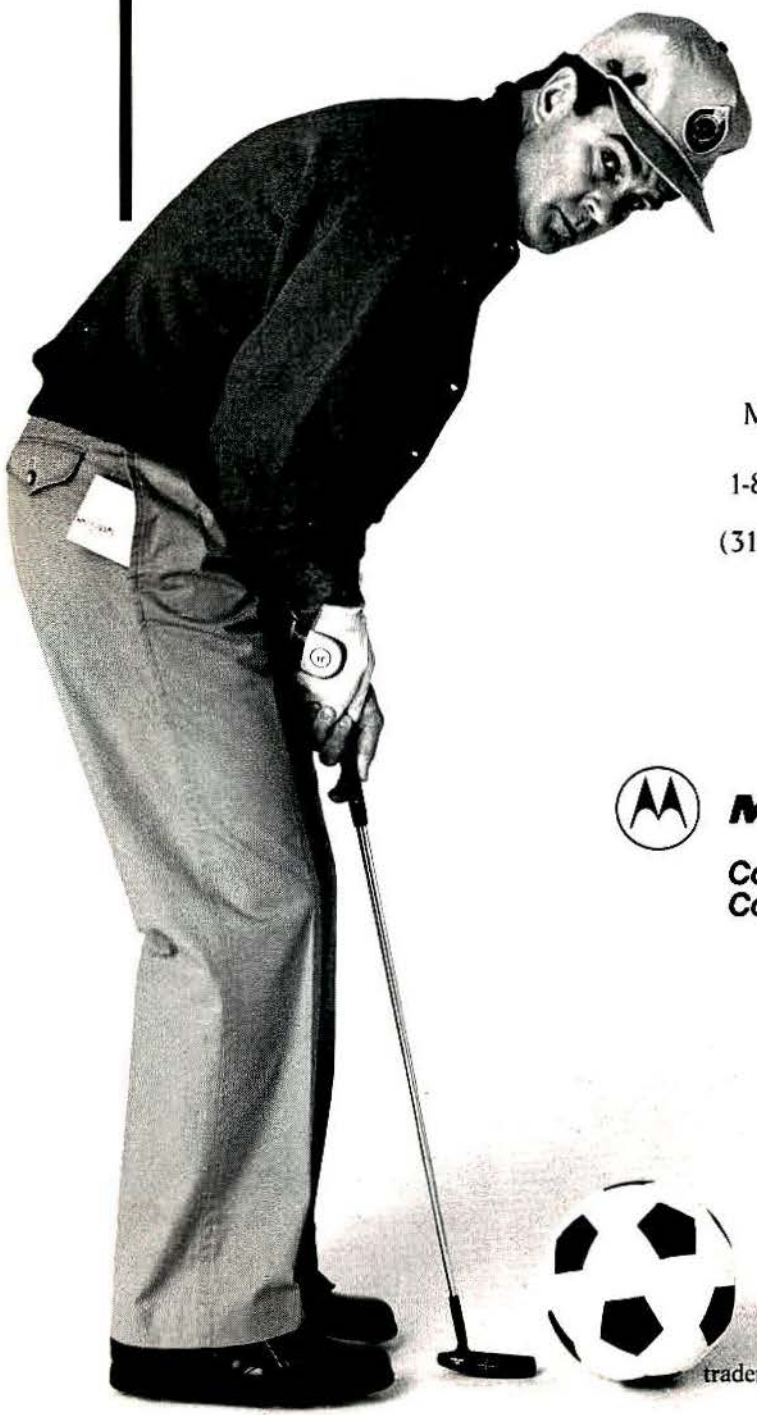


MOTOROLA INC.

Communications Systems Division
Component Products

Reader Service No. 15

Rugged DC-to-DC Converter Withstands 3000 Volt Spikes

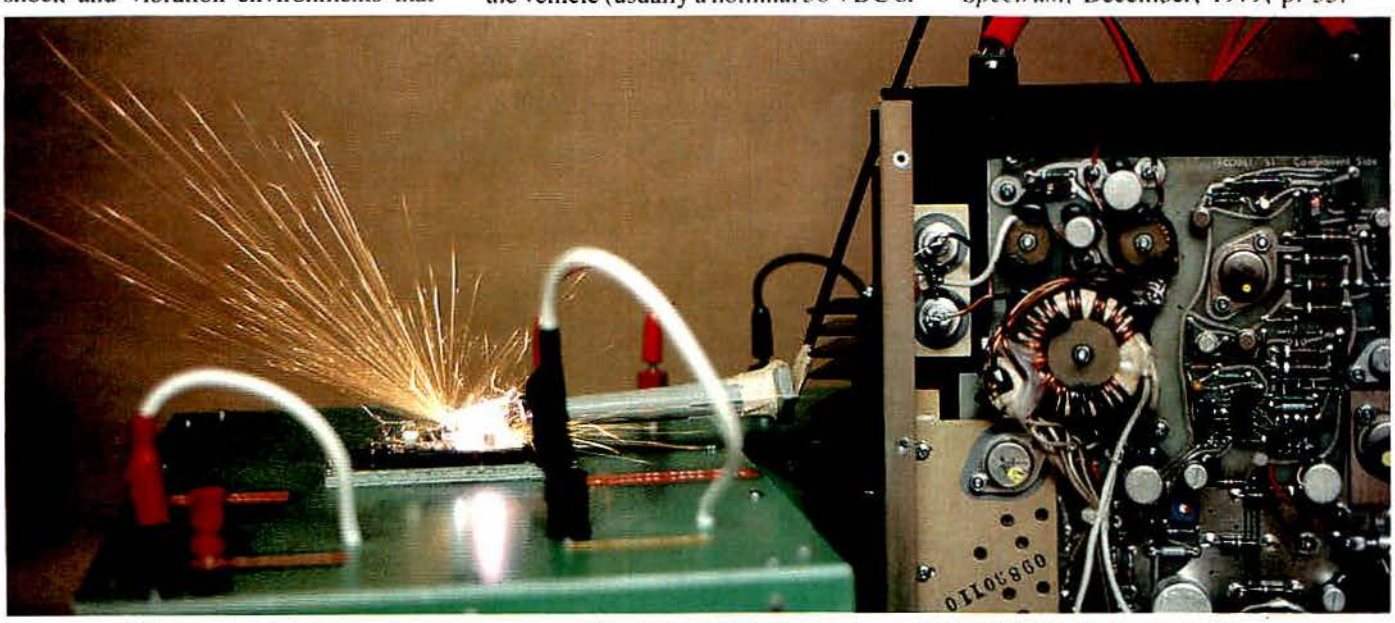
By Christopher Ely, Project Manager
Wilmore Electronics Co., Inc.

High voltage, high energy transients can destroy microprocessor-based communications equipment. Land mobile radios used by railroads can be protected by converter design which removes up to 3000 volt, 90 joule transients.

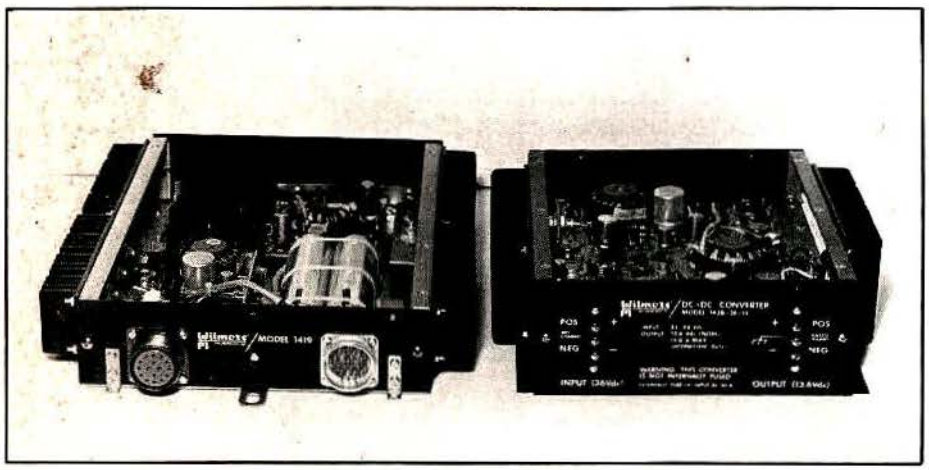
Operating land mobile radios on locomotives and mass-transit railroad vehicles presents systems designers and equipment specifiers with formidable challenges. Mechanical design considerations include severe shock and vibration environments that can produce destructive shocks and and resonant frequencies that literally shake equipment apart. The electrical environment of a railroad vehicle presents an even tougher challenge.[1]

Main electrical power buses aboard the vehicle (usually a nominal 36 VDC or 72 VDC) must be converted to a nominal 13.6 VDC while protecting the mobile radio from floating grounds, widely fluc-

[1]Mason, John F., "The LIRR: a system riding on troubled tracks," *IEEE Spectrum*, December, 1979, p. 33.



A sharp, audible report and a shower of sparks accompany the closing of a knife switch as a 3000 volt, 90 joule transient is impressed across input terminals of a DC-to-DC converter.



DC-to-DC converters power land mobile radios on railroads, withstanding severe shock and vibration combined with electrical surges, and providing up to 200 watts output power.

tuating vehicle voltages, and several-thousand-volt, high-energy transients.

A mechanically rugged DC-to-DC converter that can efficiently convert the varying input source to a regulated 13.6 VDC output while protecting the mobile radio from input transients and displaced grounds can be the most economical solution.

Mechanical problems for both converter and mobile radio are straightforward and can be effectively solved by good construction techniques and attention to detail, including thoughtful use of staking and locking compounds on larger components and mechanical fasteners. The electrical problems, however, are difficult to quantify, and, once quantified, they defy simple solutions.

Electrical systems on railroad vehicles are subject to a variety of transient-producting phenomena. Spikes and noise from high current alternators, switching of heavy electrical loads such as air conditioners and intermittent electrical faults in other parts of the system can all cause damaging voltage transients to appear on input wiring to sensitive equipment.

Perhaps the most severe transients are high-energy pulses generated by electrically powered mass transit cars. Massive power surges, created by switching hundreds of amperes of DC current, can be inductively coupled to power buses that run directly to unprotected electronic loads. These transients can be meaningfully quantified by defining two parameters of the transient waveform: peak amplitude (VDC) and energy content (watt-seconds, or joules).

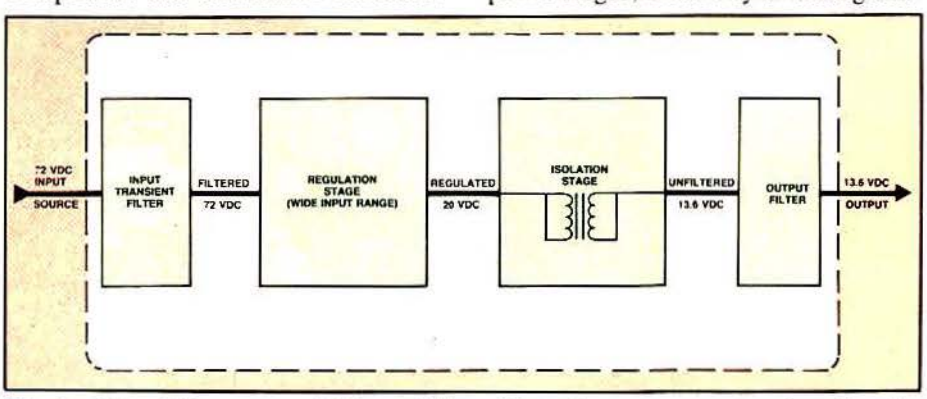


Fig. 1—DC-to-DC converter with internal filter withstands severe energy transients from its railroad power circuit input. Land mobile radios powered by the converter sustain no damage or performance degradation during the transients.

Studies on a variety of railroad vehicles have indicated that surges of 1000 to 2000 VDC in amplitude and more than 50 joules in energy content are not uncommon, prompting conservative equipment specifiers to request that communications equipment withstand transients up to 3000 VDC and 90 joules.

A better understanding of the magnitude of such a transient can be achieved by use of the equation $E = \frac{1}{2}CV^2$, where

E = energy in joules,
C = capacitance in farads, and
V = potential in volts.

Given a 3000 VDC, 90 joule transient, solving the equation for the variable C would show that the transient is equivalent to the energy stored in a 20-microfarad capacitor charged to 3000 VDC.

A word of caution: these voltage and energy levels being dealt with are certainly dangerous, even lethal, and considerable forethought and care must be exercised should one decide to reproduce this transient for test purposes. A 3000 VDC, 90 joule spike is always looking for new and unexpected discharge paths, and it simulates a darn good small lightning bolt when it finds one!

The Converter

Figure 1 shows the functional diagram of a 72 volt to 13.6 volt converter that provides a well regulated, well protected DC output to its mobile radio load. The converter can withstand input transients of up to 3000 VDC in amplitude and 90 joules in energy content. These tran-

sients are attenuated by the integral input filtering circuit and presented at the input of the regulation stage along with the nominal 72 VDC input from the rail vehicle.

The regulation stage has an extremely wide range of accommodation and regulates nondissipatively to provide a relatively constant input voltage to the isolation stage. This next stage provides more than 3000 VDC isolation between its input and its output, which is then filtered by the output filter stage and provided to the mobile radio load.

A 200 watt converter of this type can be small (less than 0.3 cubic feet) and lightweight (less than 7 lbs.). It can accept a wide input voltage range, operate over a wide ambient temperature range (convection-cooled) and provide a well regulated, low ripple DC output.

The flexibility of its design allows for scaling of input transient protection, output power levels, and input/output voltage combinations to meet virtually any requirements found on today's railroad vehicles, including "third-rail" powered mass transit cars.

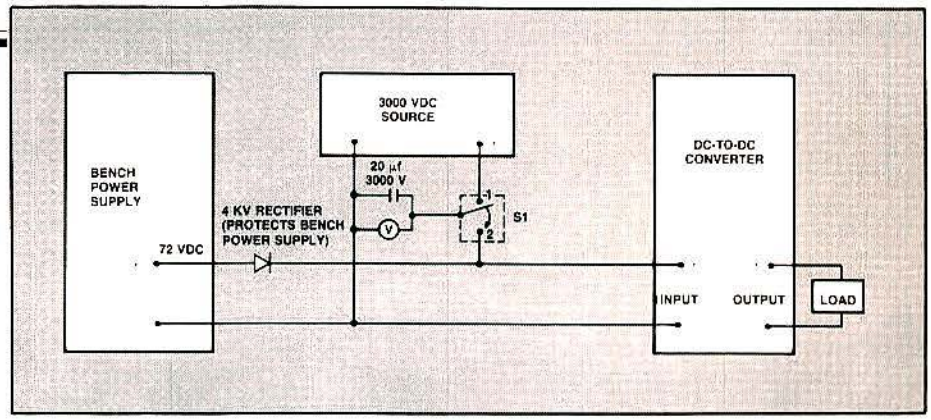


Fig. 2—Bench test set-up applies a 3000 volt, 90 joule transient spike to the input of a DC-to-DC converter.

Testing the ability of a piece of electrical equipment to withstand the *actual* transients found on a particular railroad vehicle is time consuming. The only way to genuinely do this is to install the equipment to be tested on the vehicle and let it run, perhaps for years.

A practical bench test has been developed, however, that allows testing the equipment to a particular transient-withstand specification. The test is a worst-case one when correctly done because it does not make use of the input source impedances which exist in actual railroad vehicle wiring and which would reduce the amplitude and energy content of the spike.

Figure 2 shows the simplified schematic diagram of a test set for producing a 3000 VDC, 90 joule transient energy spike directly across the input of a DC-to-DC converter while it is operating. The converter is powered by a bench power supply whose output is protected from the spike by diode isolation in the positive lead. This diode isolation also prevents the output filter of the bench power supply from attenuating the test transient.

Switch S1 is closed to pole 1 and

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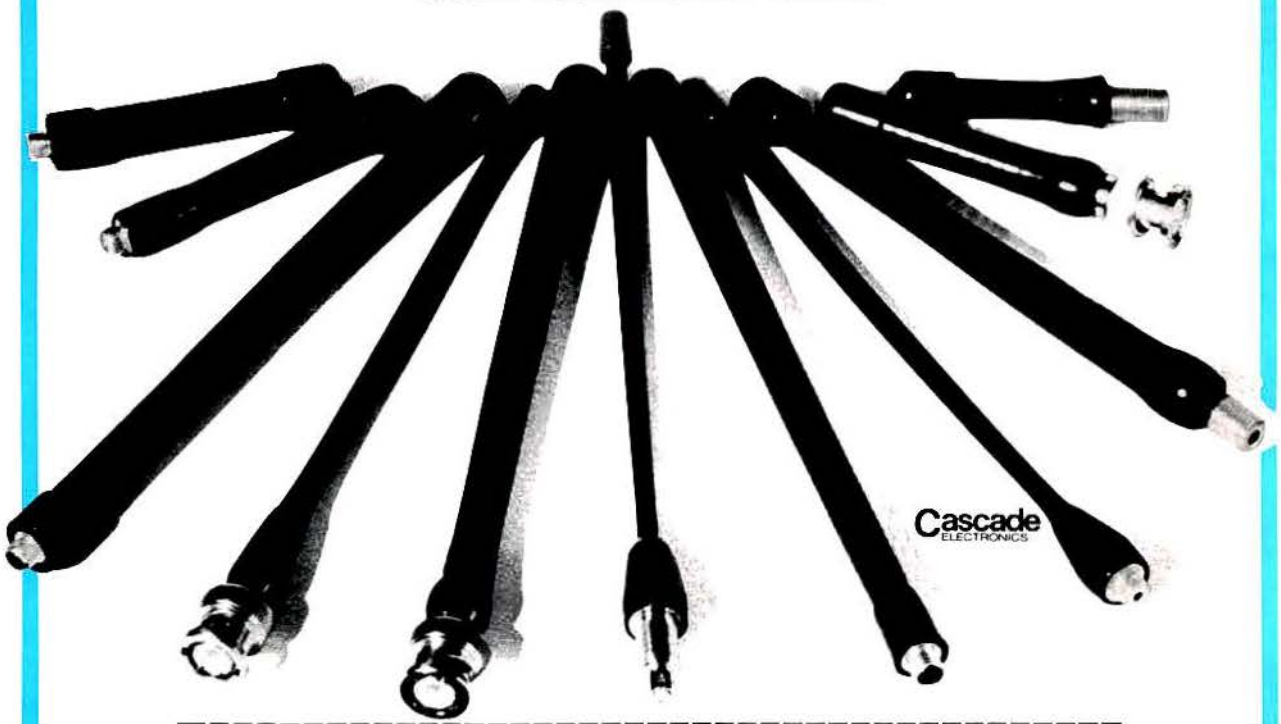

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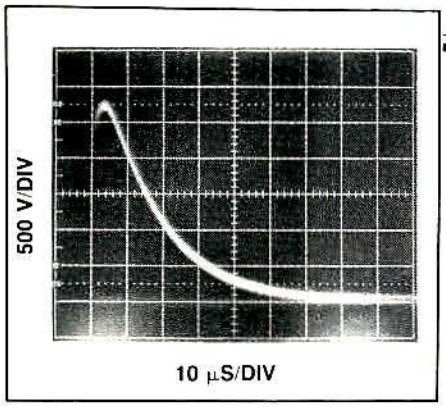

Fig. 3A—High voltage spike from a 20 microfarad capacitor is discharged across the input terminals of DC-to-DC converter.

allows a high voltage power supply to charge a 20 mfd capacitor to 3000 VDC. The switch is then closed to pole 2, abruptly jolting the input to the DC-to-DC converter with the full 3000 VDC, 90 joule transient. Leads from the capacitor to the input of the converter should be short to reduce their impedance and ensure that the converter is subjected to the full violence of the test transient.

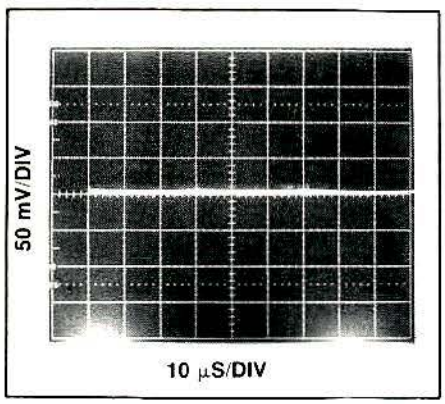

Fig. 3B—Output voltage of converter remains unchanged during input transient.

Not only is it important that the converter *withstand* the transient, but it must also *attenuate* the transient to the point that no degradation of operation occurs in the mobile radio that it is powering. The oscilloscope traces shown in Figure 3 are photographs of the input and output voltages appearing at the terminals of a converter of the type shown in Figure 2 during a high-voltage transient test.

The first trace shows the input to the converter rising to a 2.8 KV peak and gradually decaying back to the input voltage level. The second trace is the steady 13.6 VDC output for the duration of the input transient test conditions. Also, the simplified schematic in figure 2 is just that—*simplified*. Adequate safety provisions must be provided when constructing such a test set, including but not limited to such considerations as adequate fixture insulation and remote enabling of switch S1.

Conclusion

Hundreds of DC-to-DC converters of this type are in service worldwide on diesel and electric locomotive, mass transit cars and light rail vehicles. They are reliably powering mobile radios, public address systems and other sensitive electronic loads.

The ability of these converters to survive the harsh mechanical and electrical environments of diesel and electric railroad vehicles offers systems designers, manufacturers, and installers an economical means of powering virtually any electronic equipment, including microprocessor-based systems, in railroad applications.


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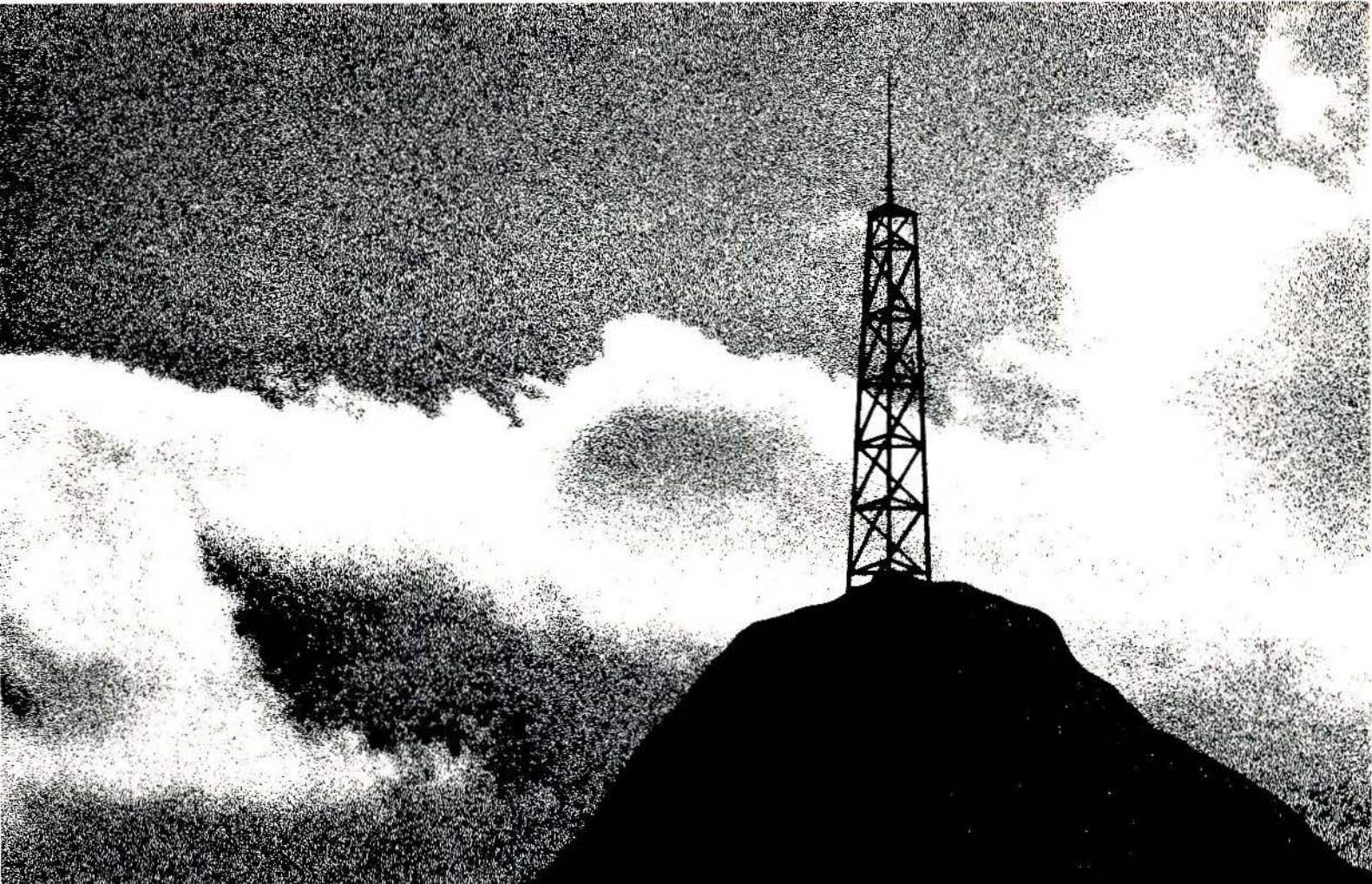

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Intermod Control—Part 5: Receiver Multicoupling

By William F. Lieske
EMR Corporation

Receiver multicoupling reduces intermodulation interference and the need for separate receiving antennas. In this installment of the intermod article series, noise figure is defined and multicoupling methods and devices are discussed.

Receiver multicoupling allows reception using two or more receivers connected to a common antenna with equal—or better!—performance than could be obtained with each receiver using a dedicated antenna.

The first important factor in performance is *receiver sensitivity*, or the ability of a receiver to produce a demodulated signal output of a stated characteristic measured against the reference of a modulated signal input of a given strength. In amplitude modulated systems, sensitivity has been defined in various ways. For example, one functional definition of minimum sensitivity requires an input level (measured in microvolts) of a 30% modulated signal to produce a signal plus noise output 10 dB above the no-signal noise output.

Factors that more specific measurements may determine include the receiver's RF bandwidth, audio frequency response, hum levels and demodulated signal distortion. Where special modulation systems are employed such

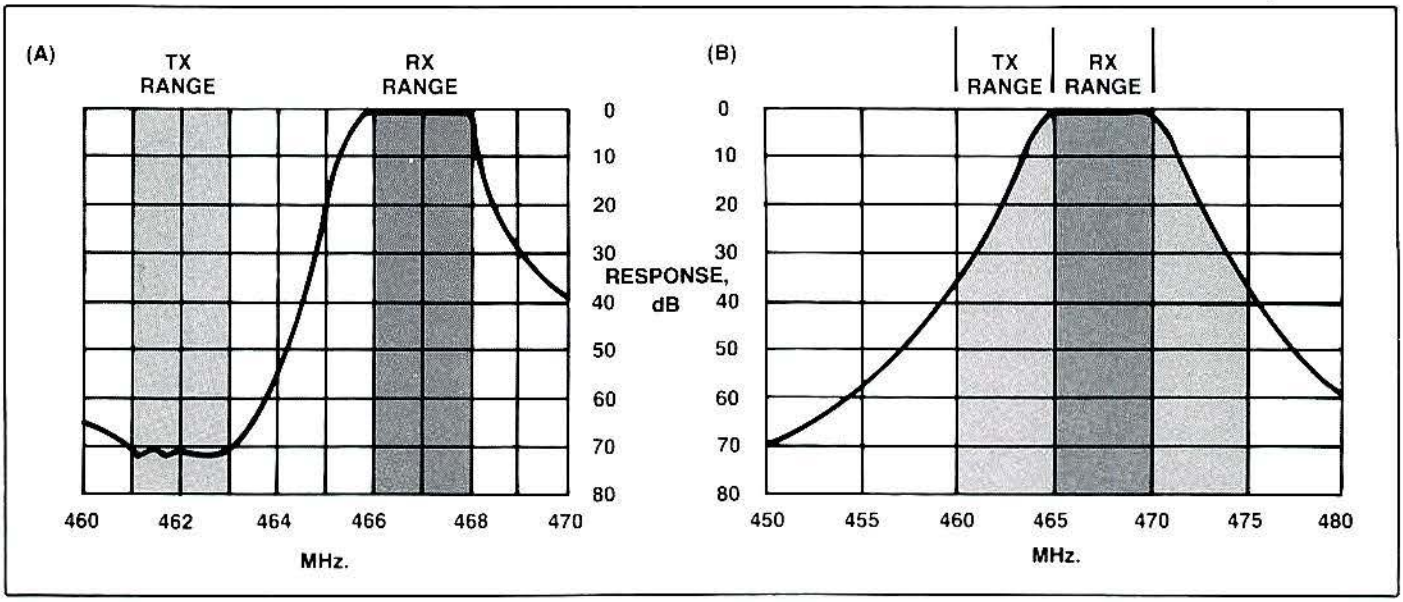

Fig. 1—Receiver multicouplers combine preselectors with amplifiers. Preselector responses are tailored to fit site requirements. Pass-reject preselector response curve (A) shows 70 dB rejection of transmitters on 450 MHz frequency pairs. Bandpass only preselector response curve (B) has limited rejection and would require at least 65 dB of isolation provided by antenna isolation to reject transmitter carrier and noise.

as single sideband suppressed carrier (SSB), amplitude compandered single sideband (ACSB), and others, various standards have been developed according to the system involved.

For frequency modulation systems employing a wide modulation index like that used in commercial broadcast, one particular set of sensitivity measuring standards is used. For vehicular communications' narrow band systems, the only standard used for many years was 20 dB quieting. This referred to the amount of unmodulated signal (in microvolts) necessary to reduce the receiver's no-signal audio noise output by 20 dB.

Within the past 15 years the 12 dB SINAD measurement method has become more or less standard. This approach relates recovered modulation referenced to noise *and* distortion.

Note that *noise* is always a factor in sensitivity measurements. Since man made, atomospheric and even solar noise impinges on the antenna, the nature and levels of these noises influence effective site signal-to-noise ratios. Beyond this, all elements of the receiving system including the antenna, line, fittings and the receiver circuits themselves generate thermal agitation noise resulting from inherent random molecular motion. This phenomenon was described in considerable detail in a two-part article published in ***MRT***.[1,2]

The term *noise figure* is used to rate the capability of a receiving system to detect a signal against a reference level of noise. The receiving system includes one or more receivers and pre-amplification devices. The detection capability of the real system is compared to that of a theoretical, noiseless receiver.

The noise figure is a ratio of two ratios: The signal-to-noise power ratio of the receiving system to the noise power ratio of the theoretical, noiseless receiver. The result is expressed in dB.

The lower the noise figure, the better the receiver. Greater signal sensitivity results from the receiving system's ability to discriminate between desired signal and noise.

No. of Outputs	No. of Splits	Nominal Loss (dB)
2	1	3.1-3.3
3-4	2	6.2-6.6
5-8	3	9.3-9.9
9-16	4	12.4-13.2
17-32	5	15.5-16.5
33-64	6	18.6-19.8

Table 1—Nominal insertion losses for splitter and divider combinations up to 64 channels.

The expression *third order intercept point* applies to the first stage in a receiving system (as does noise figure). A third order intercept measurement indicates the receiver's ability to accept a range of signal power levels without generating intermodulation products within the receiving system itself. The third order intercept measurement defines a level at which two signals applied simultaneously to the receiver's input will drive the first stage amplifier into nonlinear operation and produce a measured third order (2A–B) intermodulation product.

This measurement requires carefully controlled laboratory conditions if it is to be accurate. However, it does provide a reliable comparison between amplifiers, whether they are an integral part of a receiver or inserted between the antenna system and one or more receivers. Third order intercept is expressed in dB referenced to 1 milliwatt of signal power, or dBm.

The higher the rating, the better the dynamic range of the amplifier. Modern wide dynamic range, broad coverage amplifiers approach +40 dBm third order intercept ratings.

Preselectors, Power Dividers

Two other devices are common to receiver multicouplers: *preselectors* and *power dividers*. A preselector is a filter used to shape the pass and reject band responses to signals reaching the input of the amplifier stages of the receiving system. Figure 1 shows the responses of two typical preselector types. Note that the *pass-reject* type allows received signals over a 1 MHz range to be passed, while rejecting by 70 dB or more paired transmitter signals in a group 5 MHz lower in frequency.

Where sufficient antenna isolation is available, a *bandpass* preselector may be selected to provide a 5 MHz pass band and 3 to 4 dB per MHz of added rejection above and below the desired receiving frequency range. But at many 450 MHz repeater sites, the highest of the paired transmit frequencies would be very near to the lowest receiver frequencies. Special preselector designs and characteristics are required.

To feed N receivers from a common source, the input must be divided N ways while maintaining matched impedances at all *ports*. It is also desirable to provide isolation between all receivers to prohibit coupling of any possible first mixer injection frequency "bleed through" or intermodulation interference generated in any receiver front end from reaching any other receiver. For these reasons, signal *power dividers* (sometimes called "splitters") based on hybrid coupler principles are used to provide coupling and isolation simultaneously.

Many successful designs use Wilkinson type splitters (see "Intermod 4," Oct. 1983 *MRT*, page 40) with either line sections or equivalent lump constant circuitry.

Properly designed, each two-way split can be made with 3.1 to 3.3 dB of loss, 25 dB or more of isolation between receiver ports and several octaves of bandwidth. Table I shows nominal insertion losses for various splitter or divider combinations up to 64 channels.

Although other combinations of power dividing can be arranged, the losses due to components, cables and connectors will be within these ranges. It is accepted practice to terminate any unused ports with a low power 50-ohm termination to maintain good impedance matches and balance throughout the divider system and prevent signal leakage from an open, unterminated port.

Figure 2 shows a functional block diagram of a straightforward eight-channel multicoupler. The antenna feeds a bandpass or pass-reject preselector which feeds the amplifier, driving an eight-port power divider. Seven 2-way hybrid divider elements are shown in a "Christmas tree" arrangement. A suitable power supply operating from standard 115 VAC power or optional inverter-regulator supply to operate from DC sources provides filtered and regulated DC power to the amplifier.

Figure 3 shows the mechanical layout of such a multicoupler; a 12-channel 466 to 470 MHz bandpass preselector-equipped unit that occupies 7" of relay rack or equipment cabinet space. Various designs and models are available on the market with similar mechanical layouts.

Preselector designs and sizes vary widely according to system need — up to a full eight-foot relay rack of cavity resonators and related apparatus for unique, custom response-shaped systems.

Receivers

Most modern two-way fixed station receivers are vastly improved over those used ten to fifteen years ago. Considerable progress has been made in receiver preselector stages. Many use high quality multi-element helical resonator filters. Low noise balanced mixers are employed. Single conversion lattice crystal filter intermediate stages operating at frequencies of 5 MHz or higher provide excellent image response and first mixer injection signal radiation rejection.

Unfortunately, less sophisticated current production receivers, or those ten to fifteen years old, are still found in dense site service. Such receivers may have bipolar or low power JFET RF amplifier stages, triple conversion designs with inordinately broad first IF stage responses, or other deficiencies.

The RF amplifier stages for some receivers may have a third order intercept as poor as +10 dBm. Third and fifth order intermodulation products are produced readily when these receivers are subjected to several signals of a few hundred to a few thousand microvolts each within the broad input stage selectivity response. One such receiver presented a first mixer injection frequency signal of over 80 microvolts to its antenna jack!

No amount of careful multicoupler design will correct the inherent shortcomings of an inadequate receiver design. Dense site situations require state-of-the-art receivers, designed for fixed

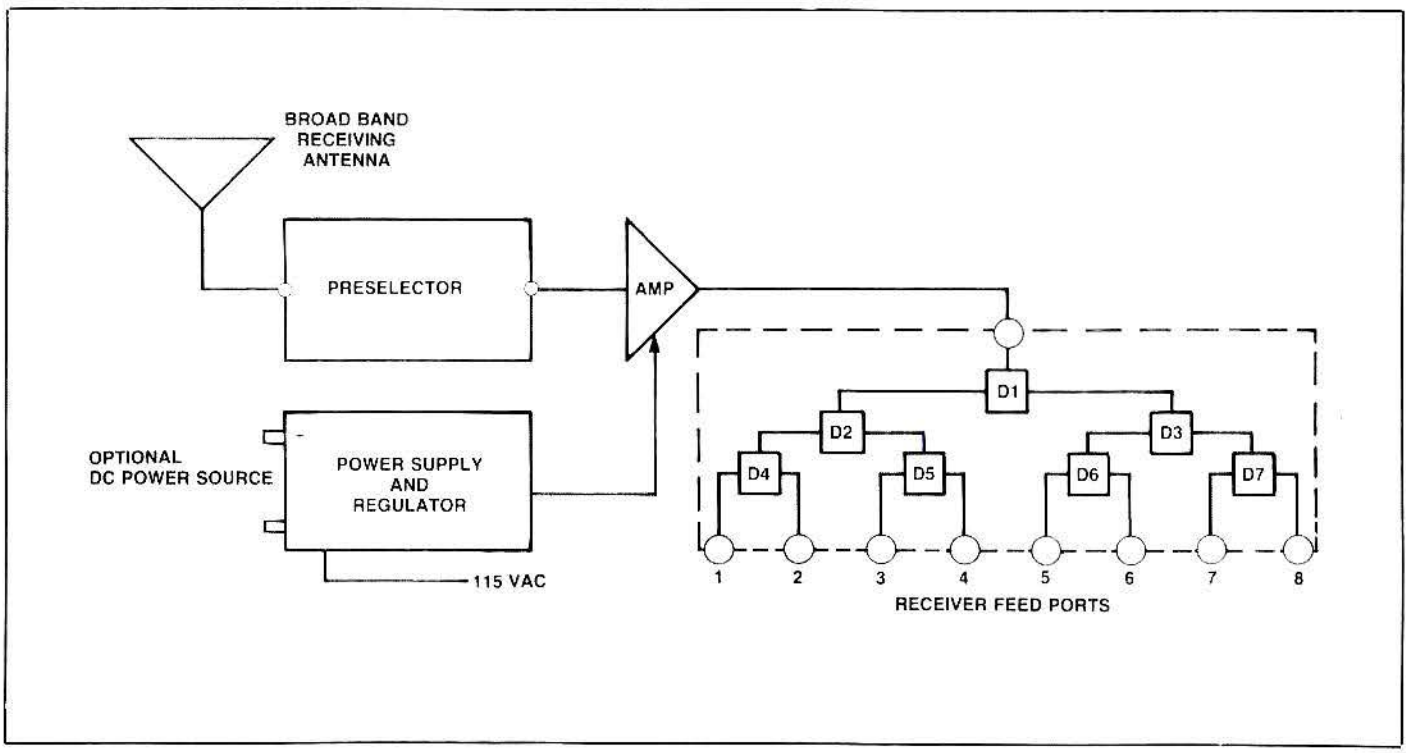

Fig. 2—Eight-channel multicoupler uses preselector with standard bandpass, custom pass-reject or other characteristics to meet system requirements. Low noise figure wide range amplifier uses available 12, 24 or 48 VDC power source and power supply to provide 20 to 36 VDC required by amplifier. An 8-way power divider is composed of seven 2-way elements.

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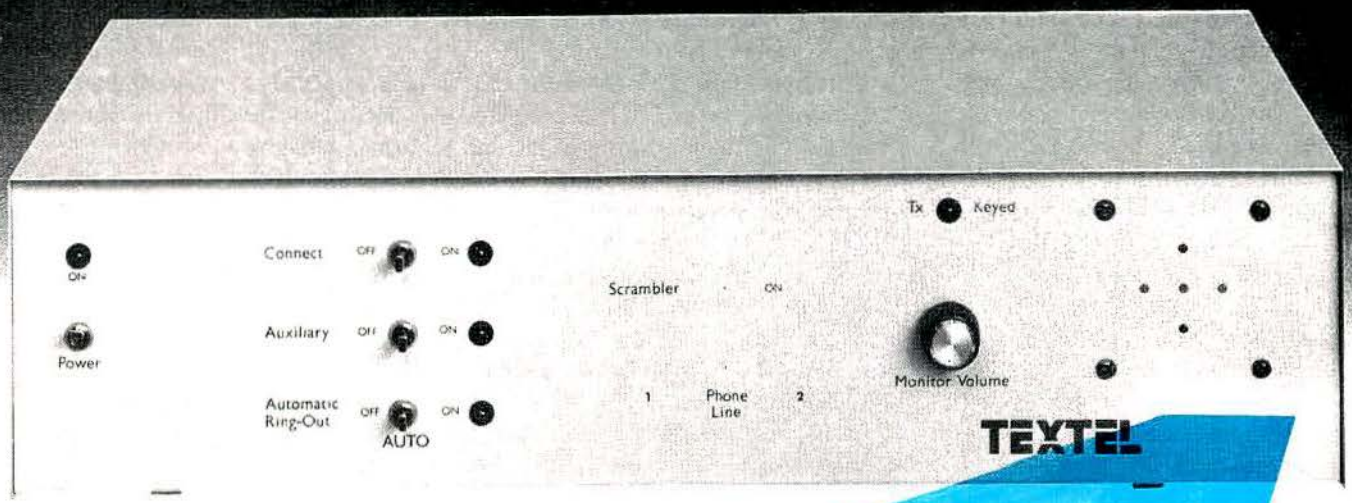

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Occasionally, a good multicoupler will help improve the performance of a so-so receiver due to preselector and low amplifier noise figure characteristics. However, receivers must be examined for spurious radiation and susceptibility to unwanted response even as transmitters are evaluated as a source of interference problems.

The characteristics of the *first stage* of amplification in a receiving system will determine the system *noise figure*. Any losses or sources of noise preceding that stage will serve to degrade the *effective* system noise figure. For example an amplifier by itself may have a noise figure of 3 dB. There may also be 1.5 dB of line loss from the common antenna and a loss of 2.5 dB in the preselector.

These losses increase the amplifier noise figure dB for dB. In this case the effective system noise figure rises to 7 dB. Something may be done about the line loss. But where very narrow response, sharp skirt selectivity filters are needed, insertion loss will be higher. Therefore, certain compromises must be accepted in preselector filter design, consistent with overall performance needs.

One approach is to determine the site noise environment prior to establishing the final multicoupler design. The measurement shown in Fig. 4 reveals measured sensitivity "masking" in a receiver of known performance. With the antenna removed and the antenna end of the "isotee" terminated with a good 50-ohm load termination, the receiver's 12 dB SINAD sensitivity is measured. The load termination is replaced with the antenna feed line and the 12 dB SINAD remeasured. The difference in the two measurements is a fairly accurate estimate of the *site noise*. For example, if 0.3 microvolts is measured as reference sensitivity, and 0.8 microvolts is measured with the antenna connected, (a situation not too uncommon at dense sites!), the best usable sensitivity with that will be about 0.8 microvolts regardless of noise figure of the receiving system alone.

In this case the system effective performance might be improved with a very sharp preselector filter (even though it has 3 to 4 dB of insertion loss), since some of the broad band noise that otherwise masks the desired signal would be rejected. It can also be seen from this example that if excess gain were provided in the multicoupler, no true benefit would be gained since both site noise and desired signals would be amplified equally.

At a site relatively free of noise, several dB of gain over that required to overcome preselection and power dividing losses may be used with good results. Too much gain, however, can cause receivers to be overdriven into front-end intermodulation product generation, or, if the receiver has front-end AGC, the receiver may be desensitized by strong, amplified off-channel signals.

During the past few years, several manufacturers have developed multicouplers that use tower-mounted preselectors and amplifiers to overcome the loss in effective noise figure caused by long transmission lines. Such a design is shown in Fig. 5. A weatherproof housing encloses a preselector, amplifier and RF-DC coupler permitting DC power for the amplifier to be conducted by the feedline. The rack mount chassis contains another DC coupler, power dividers and a power supply. Actual improvement in effective sensitivity of 7.5 dB has been measured in a 16-receiver, 450 MHz system with the receiving antenna mounted atop a 180-foot tower. An improvement of over 9 dB has been measured in a 20-channel trunk, 800 MHz system using a receiving antenna mounted atop a 120-foot tower.

Lightning Hazard

This dramatic improvement is not without potential hazard, however. Placing the amplifier at the top end of the coaxial line reduces the swamping effect of the line on lightning spike energy, making the amplifier more vulnerable to

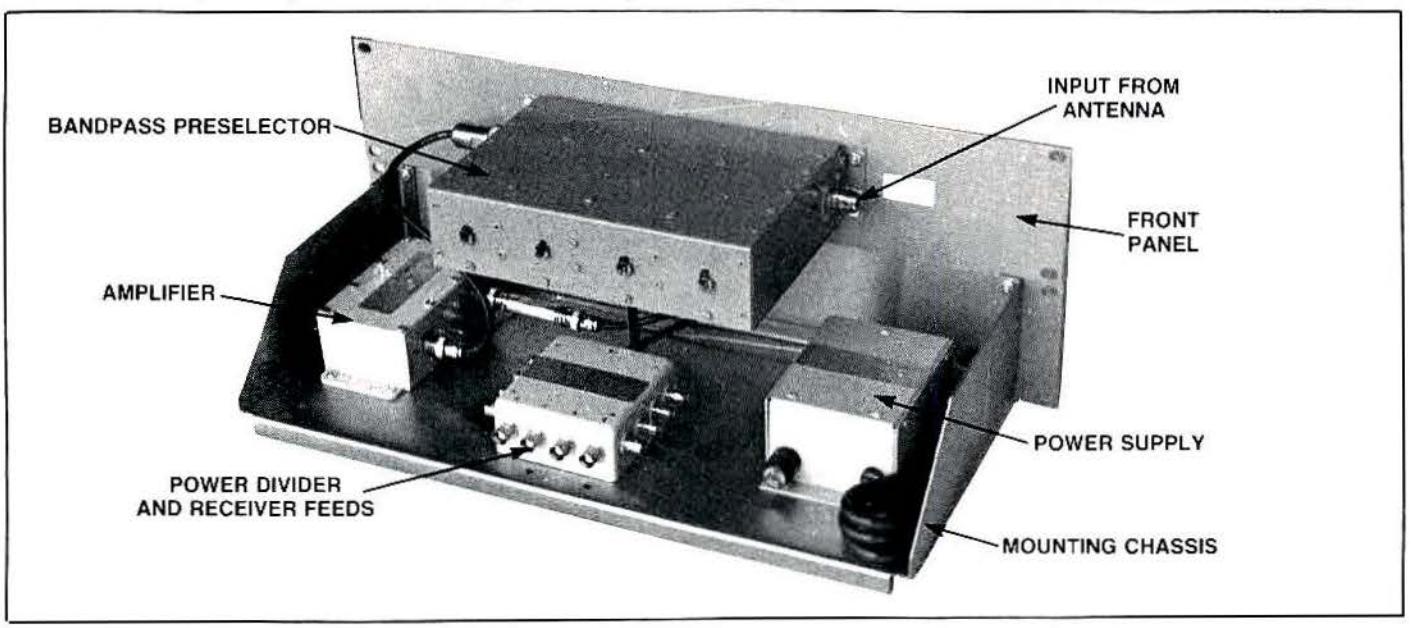

Fig. 3—Mechanical layout of a 12-channel, 450 MHz receiver multicoupler.

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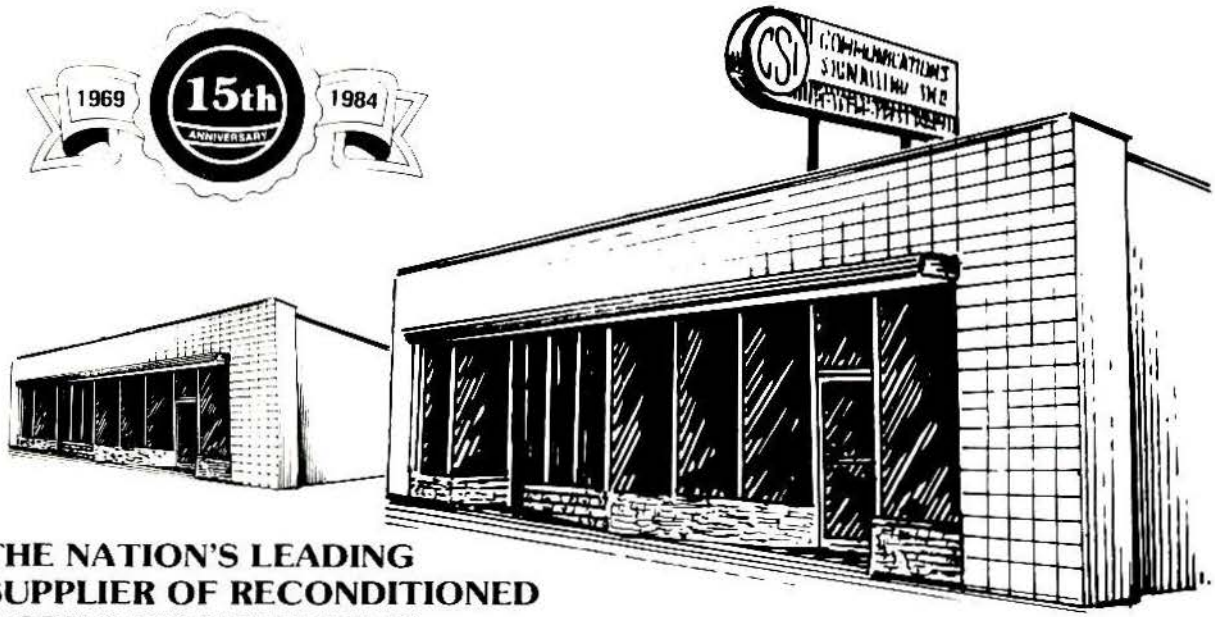

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lightning damage. Also, the effects of wind, vibration, moisture, temperature change and other environmental conditions places greater strain on amplifier design and component characteristics.

The use of a specially designed, grounded loop type, port-coupled preselector and DC coupler protected by metal oxide varistors (MOV), high pulse power rated Zener diodes, other filtering and a very high grade amplifier, have prevented failures at a number of locations with high lightning activity over a 2½-year test conducted by the author.

A well designed multicoupler provides many benefits. With proper preselector design, optimum filtering is provided. The performance of all receivers in the overall system is enhanced by a low noise figure, wide dynamic range amplification and the most favorable location for the common receiving antenna. With proper site analysis and design, much greater freedom is provided for the deployment of transmitting antennas to best suit a coordinated combining plan.

The major shortcoming is that all of the eggs are in one basket. If the multicoupler fails, or its antennas or line degrades or fails, *all* receivers may be degraded or out of service. For this reason, standby capability is recommended whether the multicoupler is installed in the equipment or tower-mounted.

A spare receiving antenna and line, and a spare or stand-by preselector-amplifier, allows service to be restored with a flip of a power transfer switch and a jumper cable change from the main amplifier output to the spare to feed the common power divider system. The cost is minimal compared with the loss of service costs or unscheduled emergency conditions.

There is a lot of interest in the relatively new GaAs FET amplifiers now on the market. These devices can produce 30 dB gain with noise figures as low as 0.5 dB. They can make most dramatic differences in receiver performances where low site noise floors exist and sufficient isolation between transmitting and receiving antennas is available.

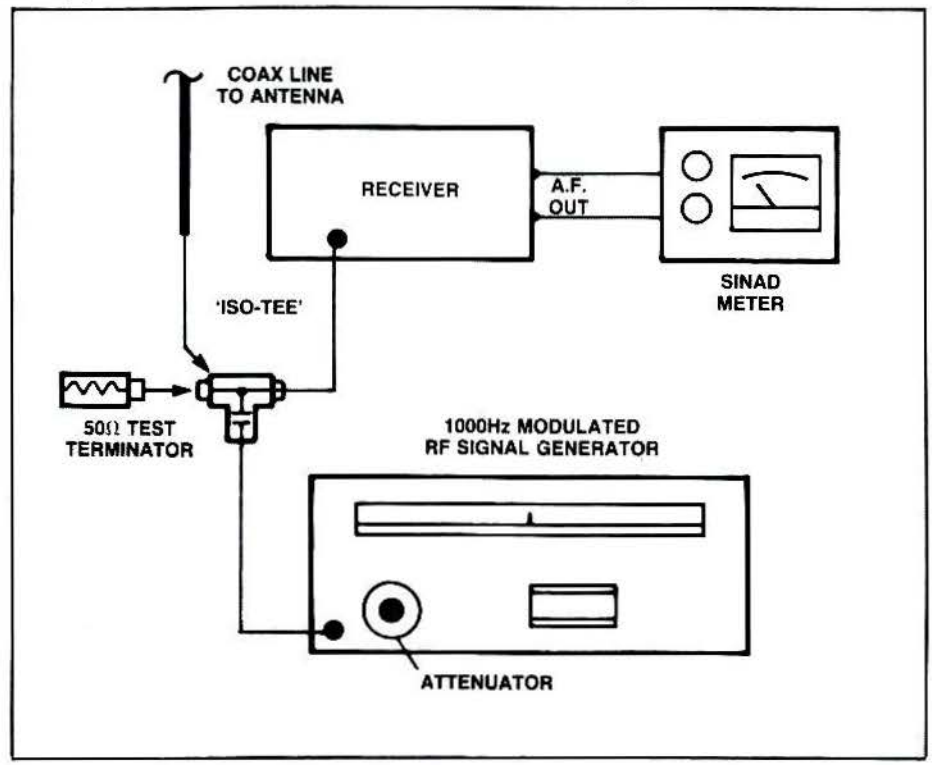
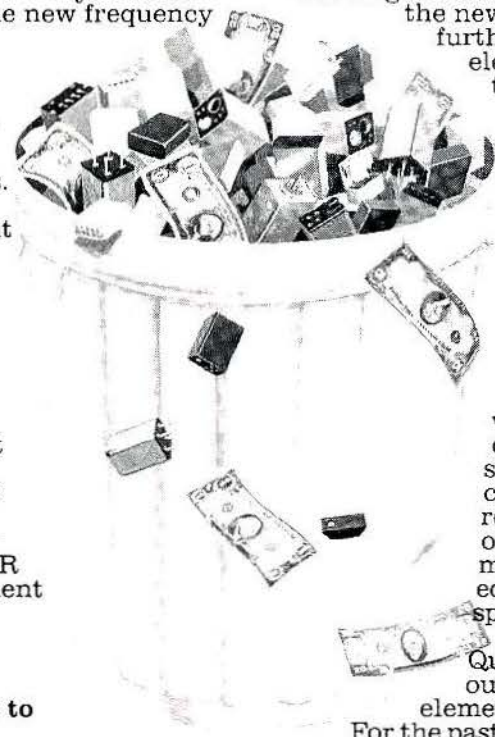


Fig. 4—Sensitivity 'masking' is revealed by measurement setup and procedure. (1) With a 50-ohm test terminator connected to the "tee," a signal level is established that produces a 12 dB SINAD reading. (2) With the terminator removed and the antenna reconnected, signal level is increased to re-establish a 12 dB SINAD reading. The difference in signal levels determines the site noise floor (see text).

Throw your money away

That's absurd isn't it? Thousands of smart two-way radio dealers do it every day... unknowingly. Over the years, original equipment manufacturer's have said that you could not change the frequency in an old channel element, and that you must buy a new element for the new frequency desired. They say this is necessary so the new element can be calibrated, and if required, compensated to meet the original equipment specifications. We feel that every time you throw a used element in the trash can that you are throwing your money away.



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When we receive elements from our customers, they are subjected to a series of rigid tests. The first step is testing the element itself to assure that it is working properly. If it is necessary to replace components in the element, we can do so from our large inventory of replacement parts. When the element is determined to be working within it's original specifications, the new crystal is installed and further testing begins. The element is first tested for **trimability.** The output is checked to see that it meets or exceeds the original manufacturer's specifications. Elements that are actively modulated are tested under load conditions and adjusted to meet specifications. Using computer **controlled temperature test chambers,** the element is subjected to **temperature vs frequency tests,** and **compensated** until specifications are met. After compensation, all tests are repeated to assure that the operation of the element meets or exceeds the original equipment manufacturer's specifications.

Quite often, we are asked by our customers to provide the element along with the crystal. For the past several years, International has acquired a large inventory of used elements which have been reconditioned or more precisely, remanufactured to meet specifications. We can supply these elements, with crystals when requested. Please call or write our sales department for further information on **ICM Remanufactured Channel Elements.**

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Unfortunately, the third order intercept performance of currently available GaAs FET devices is in the area of +15 to +18 dBm, which makes them vulnerable to overload under moderately dense site conditions. When the situation permits, GaAs FET amplifiers can be used with great success in multicoupling.

However, where site characteristics dictate a higher dynamic range, there are multi-junction bipolar devices capable of noise figures below 3 dB and third order intercepts approaching 40 dB. These devices usually operate best at voltages from 20 to 30 volts DC and consume several times the power of the FET series devices, to handle relatively large amounts of signal power before reaching saturation. Both current and voltage regulation plus generous RF filtering and bypassing is a must for any amplifier power source. Stable bipolar stages can produce up to 20 dB of gain, are extremely reliable and highly immune to failure due to spike or overload damage.

Vertical metal oxide semiconductor (VMOS) devices appear to possess both

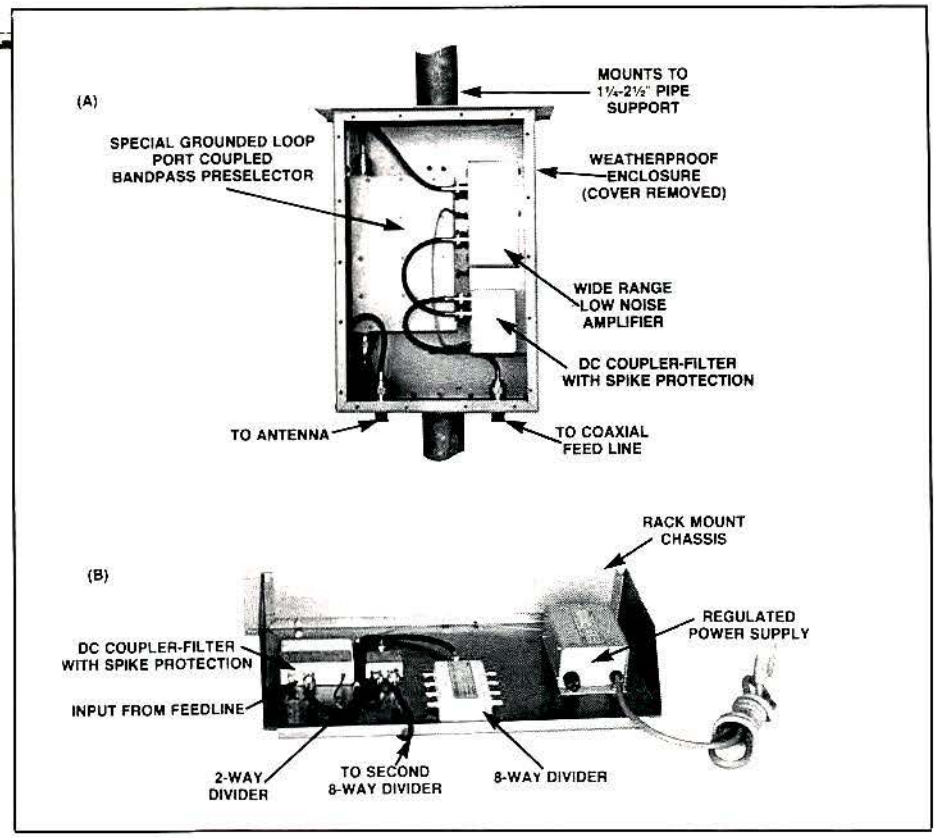

Fig. 5—Components of 16-channel, tower mounted receiver multicoupler system. Tower mounted unit (A) houses preselector and DC coupler. Rack mounted unit (B) houses power dividers, power supply and DC coupler.

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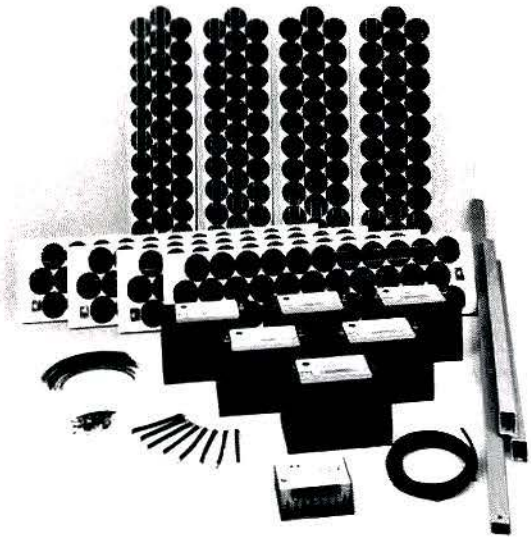

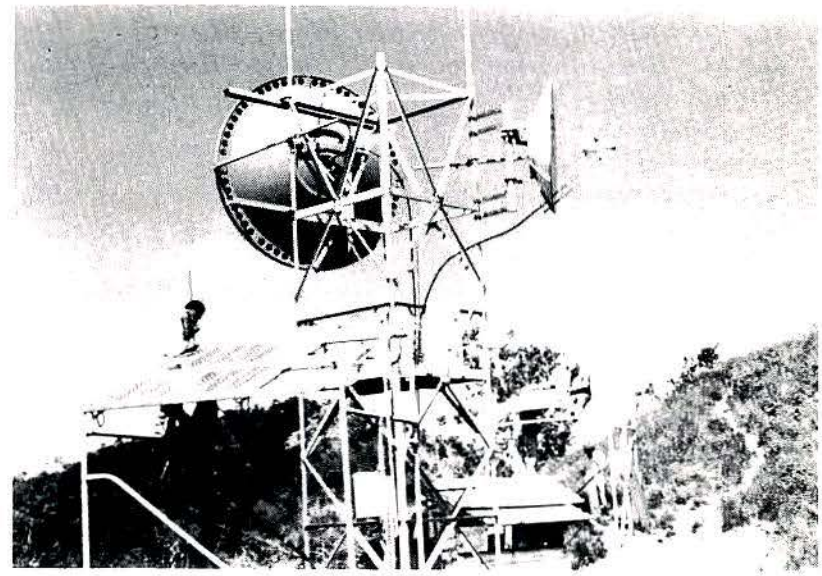

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low noise and high third order characteristics. Thus far, however, production units for operation much above 100 MHz are not available. Further developments in workable VMOS for higher frequencies are anticipated.

Summary

Receiver multicouplers are a combination of a preselector and an amplifier. The preselector is chosen to suit the range of receiving frequencies and (if required) reject certain transmitter frequencies and noise. The amplifier has sufficient gain to overcome preselector and power division losses.

Receiver multicoupling and transmitter combining are required when a site includes many duplex stations or is burdened with unacceptable interference or both.

Adequate isolation must be available between the common receiving antenna and various transmitting antennas to secure the necessary rejection of both transmitter carrier and noise. Such isolation is often obtained with collinear spacing of at least 35 feet at 150 MHz, 20 to 25 feet at 450 MHz and 12 to 15 feet at 800 MHz between the bottom of the receiving antenna and the top of the nearest transmitting antenna for each band.

Reduced collinear spacing may be used in conjuction with special preselector designs and additional transmitter noise filtering. At sites which provide only horizontal spacings, as in rooftop installations, acceptable antenna placements may best be determined by making trial antenna installations and measuring actual antenna to antenna decoupling. In either type of installation, a transmitter IM calculation must be made to determine necessary intermod suppression requirements as a part of the total site planning program.

References

1. "GaAs FET Preamps Boost System Performance." Louis Anciaux. March/April 1983 ***MRT***.

2. "Real World Applications of GaAs FET Preamps." Louis Anciaux. May 1983 ***MRT***.

The Author

William F. (Bill) Lieske has been directly involved with radio communications for more than 40 years. He has experience in military communications and radar, broadcast radio field engineering, and management of a statewide two-way communications system. Bill Lieske worked as an account executive and in sales management for a major two-way manufacturer and operating manager of a firm involved in the manufacture of intermodulation control devices prior to establishing EMR Corporation in February, 1980, in Peoria, Arizona.

Next month's installment will complete Bill Lieske's series on intermodulation interference control. Several topics will be briefly reviewed. A typical site problem will be described and analyzed to develop a site reorganization plan that can be used as a model for dense site interference problems.

Analysis Shows Advantages Of Four-Cell Site Repeat Patterns

By Morton Stern
Motorola Inc., Communications Sector

Cellular radio frequency reuse is greatest with minimum cell site separation afforded by 60-degree antennas, four-cell site repeat pattern.

One of cellular radio's advantages over previous techniques used to provide mobile telephone service is frequency reuse. Using a total allocation of 666 channels, cellular system designs limit the coverage area of individual transmitter sites to allow the same frequencies to be reused within metropolitan areas.

The methods used to implement frequency reuse determine the system's ability to serve the maximum number of subscribers within a defined area using a fixed amount of spectrum. The reuse method is an important tool in minimizing the cost per subscriber served. Current methods of implementing frequency reuse are:

(1) The use of a 12-cell site repeat pattern with omnidirectional transmit antennas (or 7-cell, in certain situations).

(2) The use of a seven-cell site repeat pattern with 120 degree antennas.

(3) The use of a four-cell site repeat pattern with 60 degree antennas.

Co-channel users are protected from interference by geographic separation and, where used, directional antennas at the base sites. When omni transmit antennas are employed, a 12-cell repeat pattern is required to insure that 90% of the area has at least a 17 dB carrier to interference (C/I) ratio since the only protection from interference is through geographic separation.

If directional transmit antennas are used in addition to geographic separation, the distance between sites can be reduced. The amount of the reduction depends upon the aperture of the antenna and the cell pattern employed. When 60 degree antennas are used, each omni cell is divided into six smaller cells. The corresponding repeat pattern consists of four sites and 24 sector cells.

A sector cell is defined as an area with a unique frequency set, so that a vehicle leaving that area requires a new channel assignment (handoff). If 120 degree antennas are used, the repeat pattern consists of seven sites and 21 sector cells. Figure 1 shows the respective frequency plan patterns.

Co-Channel Assignment Algorithm

Motorola's channel assignment strategy gives a 20% reduction in the incidence of co-channel interference in the busiest hour. The algorithm divides the channels into groups and will not assign co-channels in neighboring cells unless all other channels are busy. This strategy takes advantage of the fact that, even during the busiest hour of the day (on the average), only about 65% of the channels at a site are occupied. Figure 2 is a graph relating mean channel usage to number of channels based on erlang B traffic tables.

A mean channel usage of 65% during the busy hour results from the need to provide sufficient channels to meet 2% to 5% blocking during the short periods of peaked demand in the busy hour.

An analysis of the distribution of traffic by hour in the Baltimore-Washington

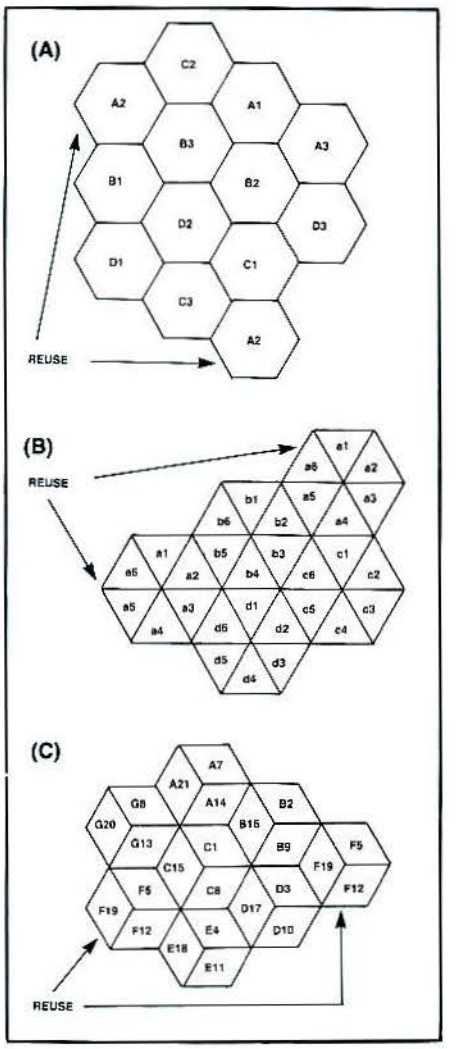


Fig. 1—Frequency reuse patterns used by cellular radio. (A) Omnidirectional antennas in a 12-cell pattern. (B) Antennas with directivity of 120 degrees in a 7-cell pattern. (C) Directional 60 degree antennas in a 4-cell pattern.

system indicates that, with this assignment algorithm, co-channel interference would only be possible (on the average) during the two busiest hours of the day.

During the remainder of the day this algorithm will (on the average) eliminate co-channel interference completely.

Sector Sharing

An obvious disadvantage to implementing frequency reuse with 21 or 24 frequency sets (as compared to 12 in omni) is the automatic degradation in trunking efficiency due to the smaller number of channels in any one group. As an example, with 21 frequency sets, there can be only 15 channels in each set; and with 24 sets, there can be only 13 channels in a set. This can result in a smaller number of subscribers per radio channel implemented, if a consistent grade of service is to be maintained.

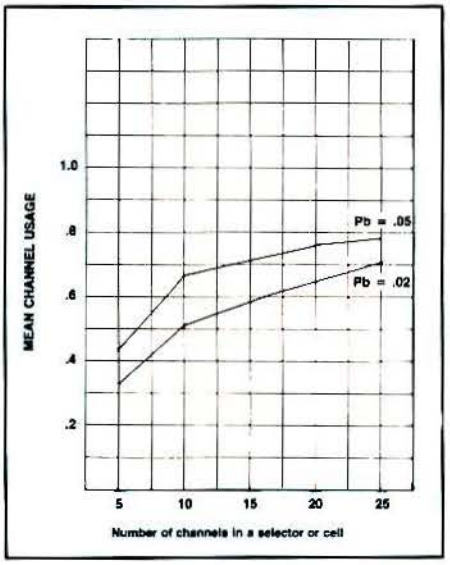


Fig. 2—Mean channel usage for blocking percentages of 2% and 5% indicate the number of channels required for a cell or cell sector, based on erlang B traffic tables.

To improve the trunking efficiency, the four-cell plan employs a technique called *sector sharing*. This is a method of assigning channels so subscribers requesting service can be temporarily assigned a channel from an adjacent sector if all of the channels in the desired sector are busy. If each sector could share all of its channels with its neighbors, then 24 frequency sets would appear to be 12 sets in so far as trunking efficiency is concerned. With the actual amount of overlap, the 24 sets may be considered to be 16.

A mobile driving around the cell site such that its path traces an imaginary 60 degree antenna pattern provides an example. The route would be similar to that shown in Figure 3. Along that route, the mean signal stength is constant because, as the mobile moves further from the transmitter, it is also driving towards the center of the antenna beam. This is the line of *constant mean signal strength*.

At point (A), the user tries to initiate a call. During the signaling time, the signal strength is measured in each sector. Since it is strongest in sector Y, the system tries to assign a channel in sector Y. All channels may be busy in sector Y. But if the vehicle's mean signal strength at sector Y's receiver is greater than that delivered by vehicles that are at the perimeter of sector X, the system will then assign a channel that is normally assigned to vehicles in sector X.

The area where an assignment to either of two sectors can be made is 59% of the total area. If the signal strength remains stronger in sector Y than in sector X, a handoff will be initiated when a channel is available in sector Y.

Increased radio channel trunking efficiency results in a greater number of subscribers who may be served by a cell site. A sample calculation shows the number of subscribers served by a site (see Table I).

In very large systems, the quantity of voice channels required may be reduced by greater frequency reuse afforded by 60 degree cell sectors, as shown in this

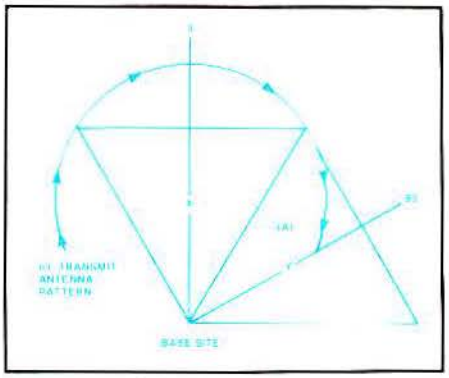


Fig. 3—Mobile travels along the line of constant mean signal strength where distance attenuation and antenna gain balance. Another mobile at point (A) in cell sector Y might use a channel ordinarily reserved for sector X under circumstances explained in the text.

example of a system serving 100,000 subscribers:

	7-cell	4-cell
Cells	82	44
Voice channels	3690	3432
Switching ports	9225	8474

Capacity is based on approximately 2.5 switching ports per voice channel. The number of voice channels required has a large impact on the size of the switching network needed.

An important measure of cell effectiveness is the *D/R ratio*, obtained by dividing the *distance* between each cell by the *radius* of the cell. The ratio can be calculated from the expression D/R = 3N, where N is the number of sites in the repeat pattern (12, 7, and 4-cell repeat patterns are used as examples):

Pattern, antenna	D/R
4-cell, 60 degree	3.464
7-cell, 120 degree	4.582
12-cell, omni	6.000

The lower the D/R ratio, the closer two

	Omni	7 Cell/ 21 Sector	4 Cell/ 24 Sector
Channels/cell	26	45	78
Subscribers	805	1223	2305
Subscribers/channel	31	27.1	29.5

Table I—More subscribers per site and per voice channel are served by 4-cell pattern than by 7-cell or 12-cell patterns.

(A)

Grade of Service	0.05
Erlang/Subscriber	0.026
Traffic Table	Erlang B
Radius of Largest Cell	8 Miles
Traffic Distribution	Uniform
Service Area	2,000 Square Miles
Number of Unique Voice Frequencies	312

(B)

Radius of Cell	8
Number of Cells	10
Channels/Cell	990
TOTAL SUBSCRIBERS	9,990
Subscribers/Voice Channel	31.9

(C)

	Omni	7-Cell, 120 deg. Antenna	4-Cell, 60 deg. Antenna
Radius of cell (miles)	4	4	4.62
Number of cell sites	40	40	30
Number of sector cells	40	120	180
Channels/sector cell	26	15	13
Reuse factor	3.3	5.7	7.5
Total channels available	1,040	1,800	2,340
Subscribers/voice channel	31.30	27.59	29.5
Total subscribers	32,040	49,061	61,130

Table II—(A) General assumptions used in calculating the number of subscribers who can be served in an area. (B) In the case of no frequency reuse, slightly fewer than 10,000 subscribers can be served in the area. (C) Relative merits of each cell-splitting and frequency reuse pattern with all cells subdivided once, as in a large metropolitan area with high subscriber density. Although it is unlikely a uniform distribution of subscribers will exist, each reuse method may be evaluated.

cells using the same frequencies can be to each other while still meeting the C/I standards. Reducing the reuse distance increases the number of subscribers who can be served in a given area (i.e., the radio channels can be used more times in a given area).

The number of subscribers who can be served in an area can be calculated. Observations can be made from the results summarized in Table II.

(1) For a given amount of spectrum, the total number of subscribers served is greater in the four-cell plan than in either the omni or seven-cell plans (69,160 vs 32,215 vs 49,061, respectively).

(2) The number of subscribers per voice channel (31.9 without frequency

(3) The four-cell pattern is implemented with 25% fewer sites than either the seven-cell or omni patterns. This is the result of reducing the radius by 0.577 when using the four-cell plan, instead of 0.5 in the seven-cell plan.

(4) The 4-cell plan results in the greatest reuse factor (7.5), also shown by the largest number of available voice channels (2,340).

Four-Cell Verification

The computer model *CELLSIM* was

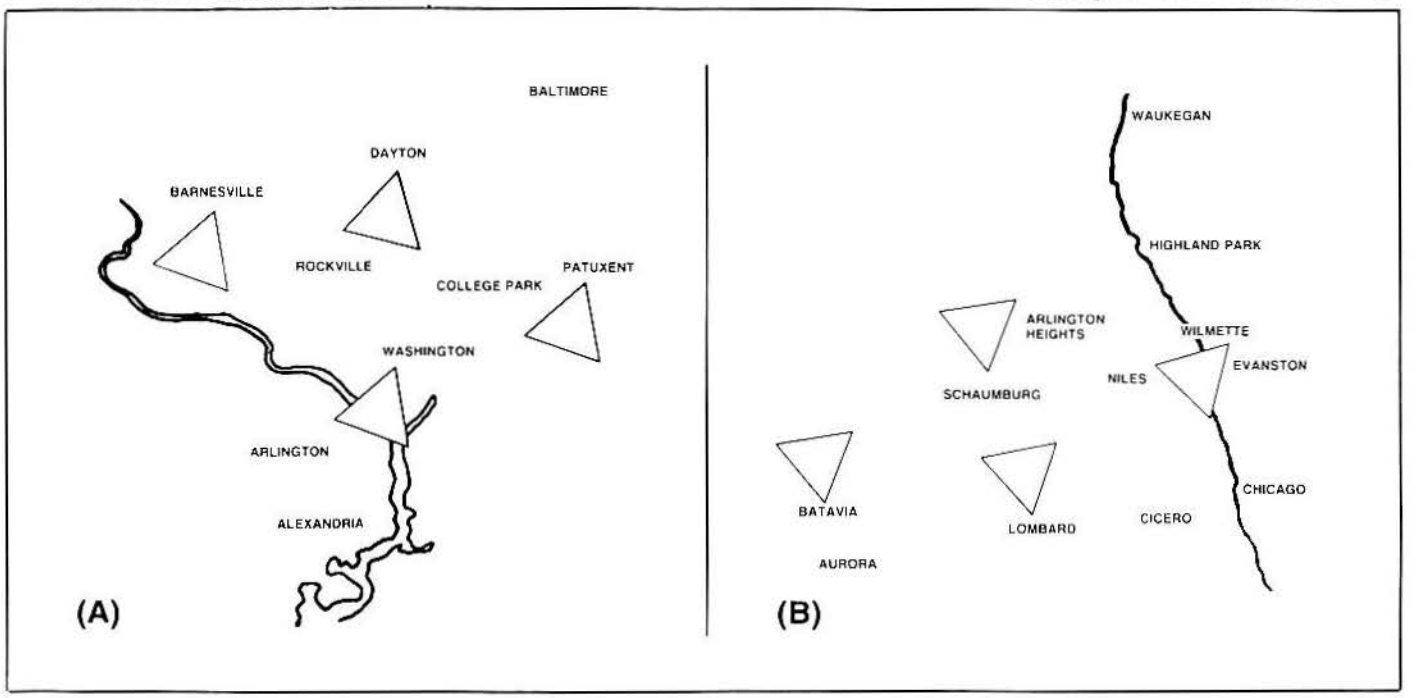
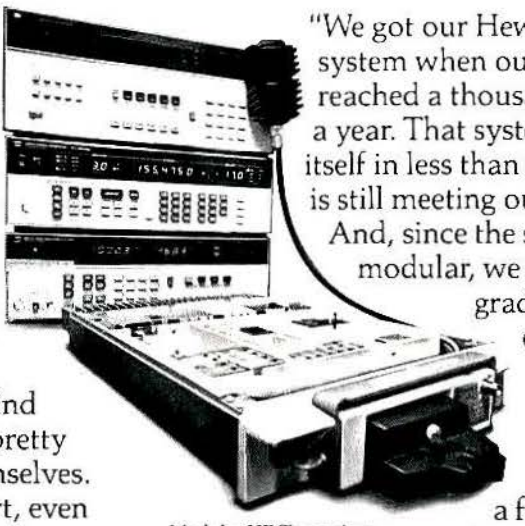


Fig. 4—The four-cell patterns in (A) the Baltimore/Washington and (B) the Chicago/Schaumburg test systems. The 60 degree antenna patterns illustrate use of front and side rejection to allow closer spacing of sectors employing frequency reuse of specific cellular radio channels.

"Our Hewlett-Packard system lets us test three times the radios—yet it's so simple our people can train themselves."

"Typically it used to take us thirty minutes to manually test a three-frequency radio. Now, with HP's Transceiver Test System, we check out an eight channel radio in eight to ten minutes—with a more sophisticated test. That helps us do our job better as well as faster—not a light consideration when your radios are used in life and death situations.

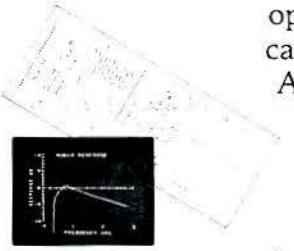
"Achieving this level of effectiveness has required very little formal training. There's no need for more than an hour or two of general familiarization. After that, we find our people can pretty much train themselves. For my own part, even though I'm not a trained programmer, I find it very easy to go into the program and make any changes we need for our particular applications.



Modular HP Transceiver Test Systems like this one can be configured to meet almost any level of test need.

"We got our Hewlett-Packard system when our volume reached a thousand radios a year. That system paid for itself in less than a year and is still meeting our needs. And, since the system is modular, we can see upgrading it easily enough when we need more capability."

There's a free brochure that can tell you more about how your transceiver test operation, large or small, can benefit from an HP Automated Test System. For your copy, write: Hewlett-Packard, Dept. T1, 1620 Signal Drive, TAF C-34, Spokane, WA 99220.



Transceiver test performance can be checked visually on the computer screen or printed out for later reference.

These comments on HP's Transceiver Test System are from Captain Ross Morris, Electrical Engineer, Washington State Patrol. Captain Morris is responsible for maintenance of Washington State's police radio system as well as those of various other State agencies.

HEWLETT PACKARD

Reader Service No. 31

1001302

THERE ARE EIGHT FACTORS CRITICAL TO THE SUCCESS OF A CELLULAR RADIOTELEPHONE SYSTEM. ONLY MOTOROLA PROVIDES THEM ALL.

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2 A flexible switch design that assures cost-effective, orderly growth.

3 Demonstrated support from a supplier who can design, install, and maintain an entire cellular system.

4 A fully integrated and compatible system from a total system supplier.

5 Optimized system coverage based on field-proven, computer-aided design.

6 Intelligent cell site equipment with remote diagnostic capabilities.

7 Comprehensive subscriber features including a full range of roaming capabilities.

8 Optimized life cycle costs to maximize return on investment.

Precision automated equipment places electronic components on a high-density circuit board at Motorola's new cellular production facility.

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Functions of a DYNA T·A·C mobile telephone are exercised using computerized test equipment.

The only fully-integrated cellular radiotelephone system.

Our DYNA T·A·C radiotelephone system is the only cellular equipment that is fully integrated from the switching exchange through subscriber instruments. It has been designed to assure that hardware and software functions are properly assigned among system elements. That optimum tradeoffs have been made and system interfaces are well defined.

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Motorola is the only equipment supplier that is producing a complete cellular radiotelephone system. We assemble every element of the DYNA T·A·C system at our new manufacturing facility in Schaumburg, Illinois. This includes the EMX family of digital electronic mobile exchanges, multi-channel base stations, base site controllers, and synthesized 800 MHz mobile and portable telephones.

Our cellular equipment production facility is a highly automated plant with a quarter of a million square feet of manufacturing space under one roof. It features computerized, in-line material flow and integrated process systems that include state-of-the-art robotics. Components are functionally tested at every level of assembly. Computer-controlled test equipment is used to exercise all sub systems and verify their integrity. As a result, we are fully prepared to answer for the reliable performance of every element in the DYNA T·A·C system.

Total involvement and support.

Our involvement with your cellular operation will go far beyond supplying the basic equipment. We custom design and install entire DYNA T·A·C systems on a turnkey basis. We include site preparation, constructing infrastructure elements like shelters and towers, optimizing all hardware and software, and training your operating personnel.

We also offer a broad range of support services to assure your cellular system operates at peak efficiency once it goes on line. Motorola-trained technicians can perform routine maintenance and emergency repairs. Multi-echelon maintenance programs are available that include remote diagnostics through our Cellular Technical Support Center in Schaumburg.

The advantage of in-depth system knowledge.

Our developmental experience with the DYNA T·A·C system will benefit your cellular operation for years to come. We will be able to assist you in planning every aspect of your cellular system and can help you realize economical, orderly growth.

We are continually evaluating the performance of customer cellular systems; obtaining the data necessary to update software functions like fault diagnosis, cell-to-cell handoff and automatic roaming. The advanced software architecture of the DYNA T·A·C system makes it possible to fully utilize this input when we incorporate enhanced subscriber features into your system.

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Making Cellular Work For You.

Reader Service No. 32

MOTOROLA

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developed to aid the system designer in studying interference limited systems. The model randomly places subscribers within the cellular coverage area and predicts the distribution of carrier to interference ratios based on a particular propagation law. The standard deviation, height of antenna, type of antenna and ERP are adjustable.

An extensive series of tests were run in both Chicago/Schaumburg and the Baltimore/Washington test systems to verify the computer model. This program was run identically in both cities. Four cells were constructed in each town. Figure 4 shows the four-cell pattern for each area.

A test van with a computer and calibrated test receiver measured the signal strength in the target cell. Base transmitters in each cell were on channels 60 kHz apart. The test receiver was programmed by the computer to spend 5 msec on each frequency. This process was repeated 50 times. After the 50th sample, a counter that stored the odometer reading was read. Each of the signal strengths were averaged and stored in the computer. The signal strength data and the distance traveled during each one-second period were stored on magnetic tape for further processing.

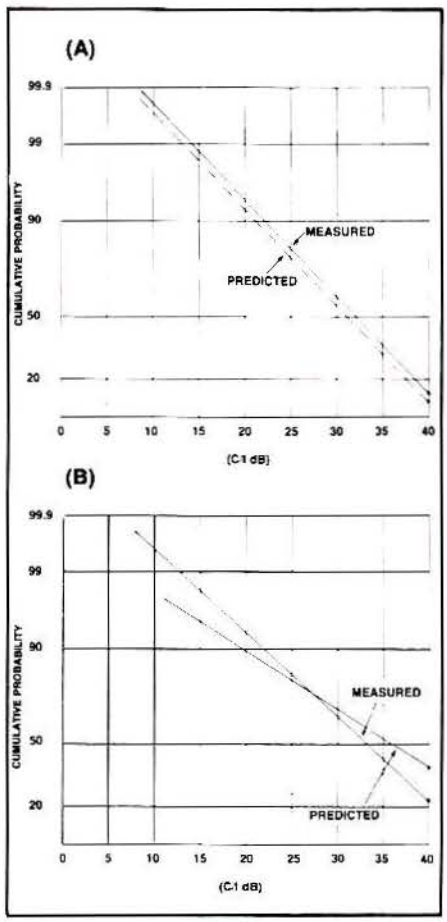

Fig. 5—Carrier-to-interference (C/I) test results of propagation analysis in (A) the Baltimore/Washington and (B) Chicago/Schaumburg cellular tests conducted to verify performance of interference limited four-cell computer model. Test van with computer and calibrated receiver measured signal strength in target cell in presence of signals from the other three cells (co-channel interferers).

Software routines were written to further analyze the propagation data. Standard deviation of the signal, correlation coefficient of the signal and each interferer, the percent of times C/I was various values, and the mean signal levels were calculated.

Measurement results were significantly better than the simulation. Because both the signal and interference travel over much the same path, sigma of C/I is less than sigma of either C or I.

Figure 5 depicts the results of those tests in Motorola's experimental Chicago/Schaumburg system and from the Baltimore/Washington system.

Propagation studies previously run at distances of less than one mile to over 20 miles from the site are the basis for the CELLSIM model. Therefore, CELLSIM was used to predict interference in smaller cells. Results are shown in Fig. 6.

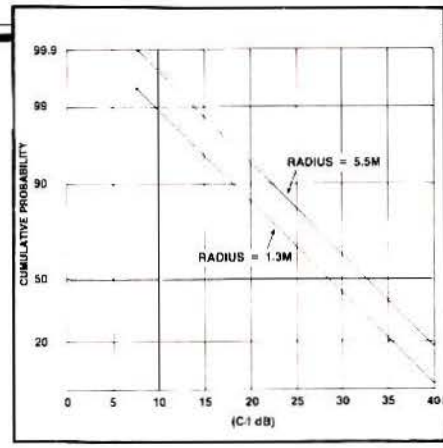

Fig. 6—CELLSIM computer model predicts interference in cells smaller than those used in the four-cell tests. Minimum acceptable carrier-to-interference ratio (C/I) is 17 dB. Performance of cells with radii of 5.5, 1.3 miles is compared.

The degradation in interference performance as the reuse distance is reduced can be improved by selectively adjusting base station power output. Since the ratio of desired carrier to interference is the important parameter in interference limited systems, reducing the power output of the interferer will directly improve the C/I in the target cell. In a uniform cell pattern, with uniform propagation laws and uniform subscriber distributions, this would be impossible, since the reduction of power output in any cell causes that cell to have poorer interference.

In real systems none of these parameters are uniform. Therefore, various combinations of power adjustment, and non-uniform channel assignments are used differently depending on the particular system.

Co-Channel Interference

Cells in reuse patterns using omni antennas are subject to interference by six interferers. These interferers form a circle around the target cell. When directional antennas are employed, the number of interferers is reduced because the back of the antennas protect some cells.

Another major benefit of directional antennas is that the worst case interferer is pushed further away:

	Worst Case
Omni	(D – R)/R 5
120° Antennas	D/R 4.6
60° Sector	(D – R)/R 4.5

Therefore, although the cells in a 4-cell pattern are closer together than the other two patterns and will provide the greatest subscriber density of the three patterns discussed, they all have approximately the same interference performance.

Conclusions

The four-cell pattern will serve the greatest number of subscribers per square mile. Therefore, it is the most spectrally efficient pattern. It reduces the number of cell sites required in the system before frequency reuse can be employed. Therefore, it is the most effective. It allows the greatest number of subscribers to be served per voice channel implemented and it has the least number of co-channel interferers in each cell pattern.

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Any cellular system built around a central switch is tied to old technology.

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With predictions varying widely on what kind of consumer demand cellular operating companies can expect, it will be very easy for a system with a central switch to be either over-engineered or under-engineered. In fact, any switch is a perfect fit for a relatively short period; the rest of the time it's either too big for the job or becoming obsolete. Our decentralized system allows for easy expansion as customer base grows, without costly replacement of hardware.

Moreover, on top of being enormously expensive itself, a central switch necessitates a massive network of parallel dedicated circuits. And the continuing cost of backhauling calls to the switch over these leased circuits can add up to additional millions of dollars in annual operating costs.

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by making sensible use of the existing telephone network. In our system all voice traffic is routed from the Satellite Mobile Center (SMC) in each cell site to the nearest telephone exchange. From there it uses the existing network to the fullest extent possible, with the connection from the SMC to the local exchange being the only new voice frequency circuit that our system requires. The result is that our system can save millions of dollars on installation and operating costs.

AURORA achieves these startling economies by bringing the advantages of distributed data processing to mobile telecommunications. A computer hierarchy, consisting of three levels of control, handles all the functions which in other systems are relegated to the central switch. This decentralized, modular design is what makes our system easily expandable, and as economical in rural situations as it is in the urban environment.

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Reader Service No. 36

Adaptive Antennas Cancel Co-Channel Repeater Interference

By Michael J. Marcus and Satyen Das*
Federal Communications Commission

Military use of adaptive antennas, or interference cancellers, has reduced the effects of jamming. Applications in land mobile radio may reduce interference, allow closer repeater spacing, increase number of available channels.

Adaptive antennas can be used to reject undesired signals in the land mobile environment, much as they have been used to reduce jamming vulnerabilities in military environments. Closer spacing of repeater stations may be made possible, resulting in more effective spectrum use and the availability of licenses in presently congested areas.

Adaptive antenna systems could use continuous tone coded squelch system (CTCSS) subaudible tones commonly used by land mobile systems as a *discriminant* to null undesired signals. Undesired signal rejection on the order of 40 dB has been reported. Calculations show a 20 dB rejection in land mobile applications could increase spectrum use up to a factor of nearly 2.8. Experimental work is needed to confirm the calculations.

Interference Canceller

An adaptive antenna or interference canceller[7] automatically reduces the gain of a receiving antenna in the direction of interference while maintaining virtually the original gain of the antenna in the direction of the desired signal. (This can also be called *spatial filtering*.) Such systems use multiple antennas. The antenna outputs combine to form the desired pattern.

Editor's Note: Authors Marcus and Das cited 11 experiments and simulations which indicate the effectiveness of interference cancellation. Six are described below. Details of the remaining five may be found in the references numbered 11 to 15 at the end of the article.

Adaptive Antenna Technology

Two omnidirectional antennas separated between a quarter and a half wavelength were used for primary and auxiliary input signals in an experiment conducted by T.A. Bristow and R.M. Romsey.[1] For 30 kHz bandwidth signals typical of land mobile FM, cancellation of 40 dB was obtained over the 30 to 76 MHz band.

Another experiment by D.M. Fiedler and C. Meincke,[2] two elements separated by 5 feet resulted in a 35 dB rejection at VHF frequencies. The system contained a discriminant circuit to differentiate between the desired signal and the interfering waveform.

A four-element array tested by A.E. Zeger and L.R. Burgess[3] containing one main and three auxiliary antennas was constructed to reduce interference in a communication radio operating in the 30 to 70 MHz band. Each monopole antenna was mounted on the corner of a square measuring 4 meters (about 12.5 feet) on a side.

Signal processing was performed at IF after downconverting the 30 to 70 MHz signals. In the outdoor test, interference suppression of 37 to 48 dB was obtained.

W.G. Swarner and A.J. Berni's[4] experiment with another four-element array with half wavelength spacing between elements in the 160.5 to 175.5 MHz band showed a cancellation of 30 to 40 dB with wideband 15 MHz operation.

A simulation by J.D. Rickman[5] applied a hybrid analog/digital algorithm to a half wavelength-spaced 4-element 70 MHz array. A cancellation of 35 dB was calculated over a bandwidth of 5 MHz.

L.R. Burgess, S.J. Rosasco and A.E. Zeger[6] performed a laboratory simulation of a 4-element processor. The array was to operate in the 30 to 76 MHz band for signal-to-interference (S/I) ratios down to -25 dB. The channel spacing was 50 kHz. Adaptive beamforming was implemented at 11.5 MHz. The square array was 5 meters on a side and was operated at 73 MHz. An interference suppression of 13 to 32 dB could be obtained for a signal-to-input power level of 0 to -25 dB.

These and other experiments and simulations demonstrate that a 13 to 75 dB cancellation of interference can be obtained over the 30 to 400 MHz band.

Antenna outputs are multiplied by a complex gain or weight to adjust their magnitude and phase. A feedback controller looks at the combined signal and adaptively adjusts the weights according to a predetermined algorithm.

Such algorithms either maximize the signal-to-noise ratio (in cases where the controller can estimate the ratio) or minimize the output power (this is useful in military applications in which the jammer mimics the desired signal). The antennas of the system can all be omnidirectional but, in some applications such as interference cancellers for radars, a main directional antenna is used along with supplemental omnidirectional antennas.

Important is the fact that the various antennas provide the controller with combinations of the deisred and undesired signals that differ in phase and, possibly, in amplitude. An antenna system of K elements can provide $K-1$ nulls. Work has been done on K values as high as 5.

W.F. Gabriel has published a review of interference cancellers.[8] P.W. Howells developed sidelobe cancellers at the intermediate frequency.[9] Gabriel credits Applebaum for subsequently presenting the associated control-law theory related to maximizing the signal-to-noise ratio. B. Widrow developed the theory of adaptive filters.[10] Both analytical methods have been expanded and digital cancellers have been developed.

Land Mobile Adaptive Antennas

In many land mobile radio systems, CTCSS is used to identify desired mobile radio signals. The subaudible tones could be used by an adaptive antenna feedback controller to identify the desired signal and to discriminate against interference.

A typical example might involve an 860 MHz land mobile system with cochannel repeaters spaced 112 km (70 miles) apart and a service area radius of 32 km (20 miles). The repeaters' ERP is 1000 watts. Field strength is calculated using CCIR Recommendation 529[16] which recommends that methods given in CCIR Report 567-2[17] be used provisionally to determine field strength in land mobile service. (In the U.S., other models are used for legal reasons. However, the basic results of this analysis are independent of the details of the propagation model.)

The desired field strength at 32 km (20 miles) is obtained from Fig. 2 of CCIR Rep. 567-2. This field strength is for *50 percent of the locations* and for *50 percent of the time*. To increase the reliability of the desired field, the ratio of the field strength for *90 percent* of the receiving locations to the field strength for *50 percent* of the receiving locations is taken from Fig. 12 of CCIR Recommendation 370-4.[18] The received desired field strength is given by: F(90, 50) = F(50, 50) –12.

The undesired or interfering field strength is taken from Fig. 2 of CCIR Rep. 567-2 for 50 percent of the locations and for 50 percent of the time. The undesired field is given by: F(50, 50). The units of the field strength are dB(μV/m).

One desired mobile radio is located 32 km (20 miles) from the desired repeater. The initial separation distance of the desired mobile radio from the undesired repeater is 80 km (50 miles). Repeater heights of 150, 300, and 1000m are considered, beginning at 300. The height of the mobile radio antenna is 1.5m.

There are two interference situations. In one case, the undesired repeater transmissions interfere with the desired mobile. In the second case, the undesired mobile radio transmissions interfere with the desired repeater. First, the interference from the undesired repeater to the desired mobile radio is considered.

Repeater Spacing

As the undesired repeater is gradually brought closer (in steps) to the desired mobile radio, the interfering field strength increases. At each closer spac-

Distance between undesired repeater to desired mobile		Unmodified Interfering Field Strength dB (μV/m)	Cancellation Needed For Retaining Interfering Field Strength to 15 dB (μV/m)	Modified Repeater Spacing	
Miles	km			Miles	km
(A) 300m Antenna Height					
50	80	15 dB	0 dB	70	112
43	68	20	5	63	101
37	59	25	10	57	91
30	49	30	15	50	80
26	41	35	20	46	74
(B) 150m Antenna Height					
50	80	7	0	70	112
43	69	12	5	63	101
37	59	17	10	57	91
30	49	22	15	50	81
26	42	27	20	47	75
(C) 1000m Antenna Height					
50	80	31	0	70	112
43	69	36	5	63	101
36	57	41	10	56	90
29	49	46	15	49	78
23	37	51	20	42	69

Table I—Results of calculations in the order presented in the text show that a modest amount of interference cancellation provided by adaptive antennas can allow a significant reduction in repeater spacing. For 300m repeater antenna height (A), spacing might be reduced from present 70 miles to 46 miles with 20 dB of interference cancellation. Reduction is less for lower, 150m antenna height (B), but greater for extreme antenna heights such as 1000m (C).

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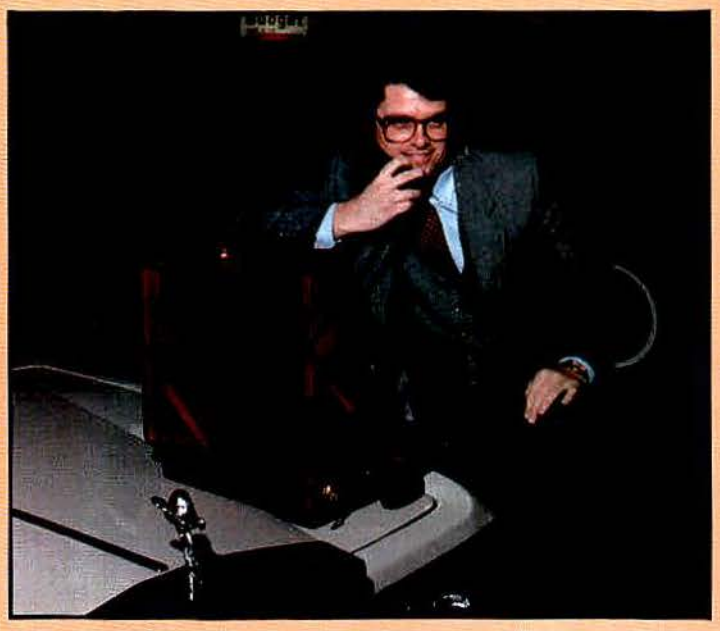

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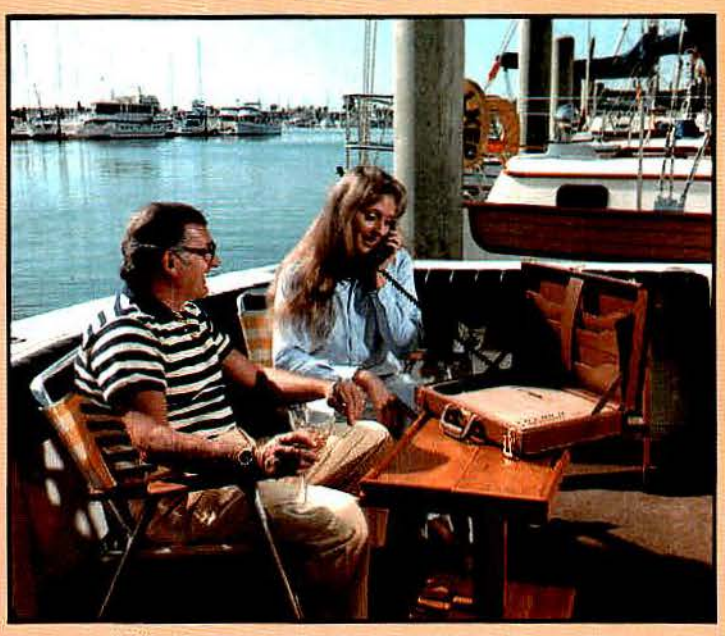

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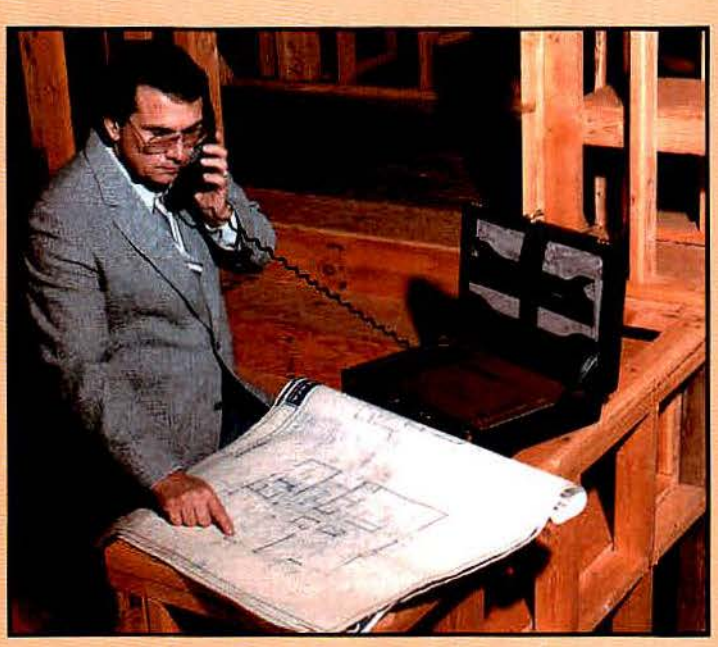
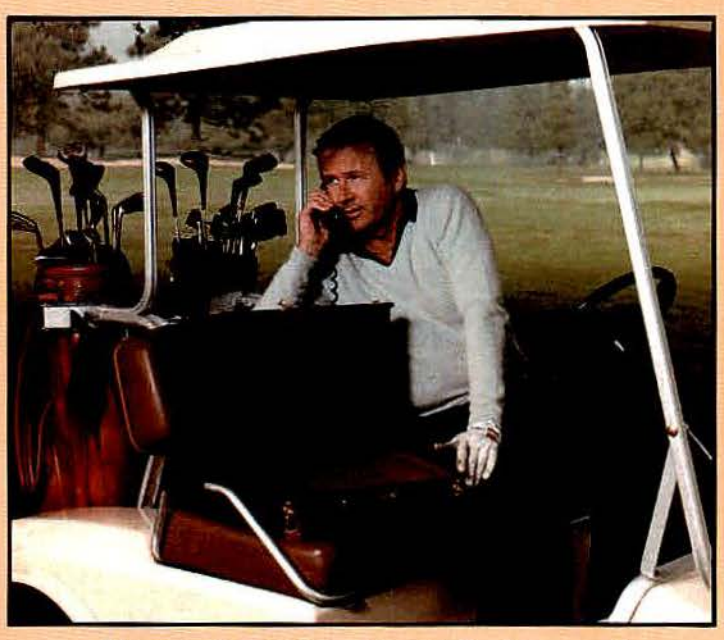


Perfect for remote location calls.



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Reader Service No. 37 345 MIRA LOMA, GLENDALE, CALIFORNIA 91024 **(213) 500-1850**

Reduced Spacing	Increased Use of Channels
50%	4 times
40	2.8
30	2.0
20	1.6
10	1.2

Table II—A small reduction in spacing made possible by adapive antennas gives a significant increase in the use of channels. Adaptive antennas may reduce spacing as much as 33 to 40%.

ing of the undesired repeater, a suitable amount of interference cancellation is added to bring the level of interference field strength back to the same level as was obtained with a separation distance of 80 km (50 miles) between the undesired repeater and the desired mobile radio.

The desired field strength at the desired mobile is from the first equation: F(90, 50) = 41 - 12 = 29 dB.

The interference field strength at the desired mobile radio from the undesired repeater located 80 km (50 miles) from the desired mobile is from the second equation: F(50, 50) = 15 dB.

Table I shows the reduced separation distance between the undesired repeater and the desired mobile radio, unmodified interfering signal strength, amount of cancellation needed to bring the interfering strength to 15 dB, and the modified repeater spacing.

The table shows that, with a modest amount of interference cancellation, repeater spacing can be significantly reduced.

Results of the same steps applied to a 15m repeater height are shown in Table II. Desired field strength at the desired mobile radio from the first equation is: F(90, 50) 33 – 12 = 21 dB. Interfering field from the undesired repeater located 32 km (50 miles) from the desired mobile from the second equation is F(50, 50) = 7 dB.

Reduced separation distance between the undesired repeater and the desired mobile radio, unmodified interfering field strength, amount of cancellation needed to bring the interfering field strength to 7 dB, and the modified repeater spacing are given in the table.

Results obtained with a 150m high repeater are similar to those obtained with a 300m high repeater, except that the reductions in spacings between repeaters are somewhat smaller than those obtained with repeater height of 300m.

Improvement In Big Cities

In cities where congestion is worst, the height of repeater antennas is often greater than 300m. For example, in Los Angeles, repeater heights of 1500m on four mountain peaks (Santiago Peak, Sierra Peak, Mt. Wilson and Mt. Lukens) require protection radii of 168 km (105 miles).

Using the same steps to calculate based upon a 1000m repeater height as with the 300m repeater height assuming a spacing of 112 km (70 miles), the desired field strength at 32 km (20 miles) from the first equation is F(90, 50) 54 – 12 = 42 dB. The interfering field strength at 80 km (50 miles) is F(50, 50) = 31 dB.

"...more improvement would occur in the largest cities where spectrum demand is greatest."

The table shows reduced separation distance between the undesired repeater and the desired mobile radio, unmodified interfering field strength, amount of cancellation required to bring the interfering field strength to 31 dB and the modified repeater spacing.

These calculations show that the benefit of the interference canceller increases with increasing repeater height. The interference canceller is more effective for higher antenna sites and therefore is more desirable if high antenna sites are to be used.

It so happens that repeater sites are highest in the largest cities where spectrum demand is greatest and improvements are most needed.

Interference, Mobile To Repeater

The case of interference from the undesired mobile radio to the desired repeater station should be considered. Because of reciprocity, all field strength

values will be identical, for identical system parameters, to the case of the interference from the undesired repeater to the desired mobile radio. However, the mobile ERP is 100 watts.

As a result, all the desired and undesired field strength levels calculated previously for repeater to mobile are reduced by 10 dB. The relationship between the cancellations needed and the modified repeater spacings shown in the tables remains unchanged.

Limitations Of Analysis

The analysis does not directly consider the effect of multipath propagation. It should be noted that multipath reflections do not appear to the antenna as a new, undesired signal, but rather as a change in the apparent amplitude and azimuth of the signal. As mobile units move, the desired and undesired field strength will randomly vary and their apparent azimuth will vary from the real azimuth. This will result in D/U ratios that sometimes exceed the capability of the adaptive antenna. However, this phenomenon is not expected to significantly change the expected results.

Another factor not considered is the point that adaptive antennas cannot reject signals coming from the same azimuth as the desired signal. Thus, there is no rejection when the desired and undesired signals are collinear. This will limit system performance in certain geographic areas for each system.

Use of the 20 dB interference cancellers would reduce the separation of distance between repeaters by from 33 to 40 percent. In a two-dimensional case, the number of channels used is inversely proportional to the area of operation or to the square of the ratio of repeater distance separations. Table IV shows the increased channel use versus reduced repeater spacing. Even a small reduction in spacing gives a significant increase in the use of channels.

Implementation Procedures

Spectrum efficiency gains of adaptive antennas can be very impressive. Yet implementation would have to follow an uncharted course. The only VHF and UHF canceller systems in development or production are military systems which cost on the order of $1,000. Commercial systems might be built in production quantities at lower cost. However, even at present costs, the system may economically be used to protect expensive repeaters from co-channel interference.

The U.S. Government has not formally considered the regulatory implications of the adaptive antenna technology. One possibility would be to require new licensees in a new band to use such technology and mandate closer spacing than at present.

Another approach might be to allow prospective repeater operators to seek voluntary agreement with existing operators, including the provision of adaptive antennas to transceivers with short spacing to be allowed upon the concurrence of all parties.

Conclusion

Application of the inferference canceller technology could theoretically improve spectrum utilization by the land mobile service. Use of this technology might permit a reduction of repeater spacing by from 33 to 40 percent compared to present practive. Reuse of land mobile channels might be increased by a factor as large as 2.8. Experimental work is needed to verify how much of this improvement may be practical.

(1) Bristow, T.A. and Romsey, R.M., 1979, "Applications of an Interference Cancellation Technique to Communications and Radar Systems," Sys. Tech. #2 38-47.
(2) Fiedler, D.M. and Meincke, C., 1979, "SNAP-1, the Steerable Null Antenna Processor ECCM Device," *The Aerospace Communicator*, 1 32-35.
(3) Zeger, A.E. and Burgess, L.R., 1977, "VHF Adaptive Array Results," International Telemeter Conference, 18-20, Los Angeles.
(4) Swarner, W.G. and Berni, A.J., 1974, "Adaptive Antenna Array and Angle of Arrival Estimation System for Sensor Communication," Ohio State Univ., Cont. DAAG 72-C-0169.
(5) Rickman, Jr., J.D., 1981, "Results from a Four Element Adaptive Antenna Experiment," *Trans. IEEE, AES-17*, 35-47.
(6) Burgess, L.R., Rosasco, S.J. and Zeger, A.E., 1976, "An Adaptive Nulling Array for VHF Radios," AP-URSI Symp., Palo Alto, Calif.
(7) Howells, P.W., 1976, "Exploration in Fixed and Adaptive Resolution at GE and SURC," *Trans IEEE, AP-24* 575-584.
(8) Gabriel, W.F., 1976, "Adaptive Arrays—An Introduction," *Proc. IEEE 64* 239-272.
(9) Howells, P.W., 1965, "Intermediate Frequency Side-Lobe Canceller," U.S. Patent 3202 990.
(10) Widrow, B., 1970, "Adaptive Filters," In Aspects of Network and System Theory, Kalman, R.E. and DeClaris, N. Eds.
(11) Siegel, D.A., et. al., 1979, "Feedback Nulling Demonstration System Hardware," Lincoln Lab. Tech. Note 1979-12.
(12) Potts, B.M., 1979, "PIN Diode Weight Circuits," Lincoln Lab. Tech. Note 1979-26.
(13) Ettinger, D.D., Jones, W.R., Masenten, W.R., Miller, T.W. and Tees, W.G., 1977, "Final Report UHF Adaptive Array Development Program," Hughes Aircraft, NRL Contract No. N00173-76-C-0353.
(14) Compton, Jr., R.T., 1976, "An Experimental Four-Element Adaptive Array," *Trans IEEE AP-24* 697-706.
(15) Cummings, W.C., et. al., 1979, "A UHF Test Simulator for an Antenna Nulling System," Lincoln Lab. Tech. Note 1979-8.

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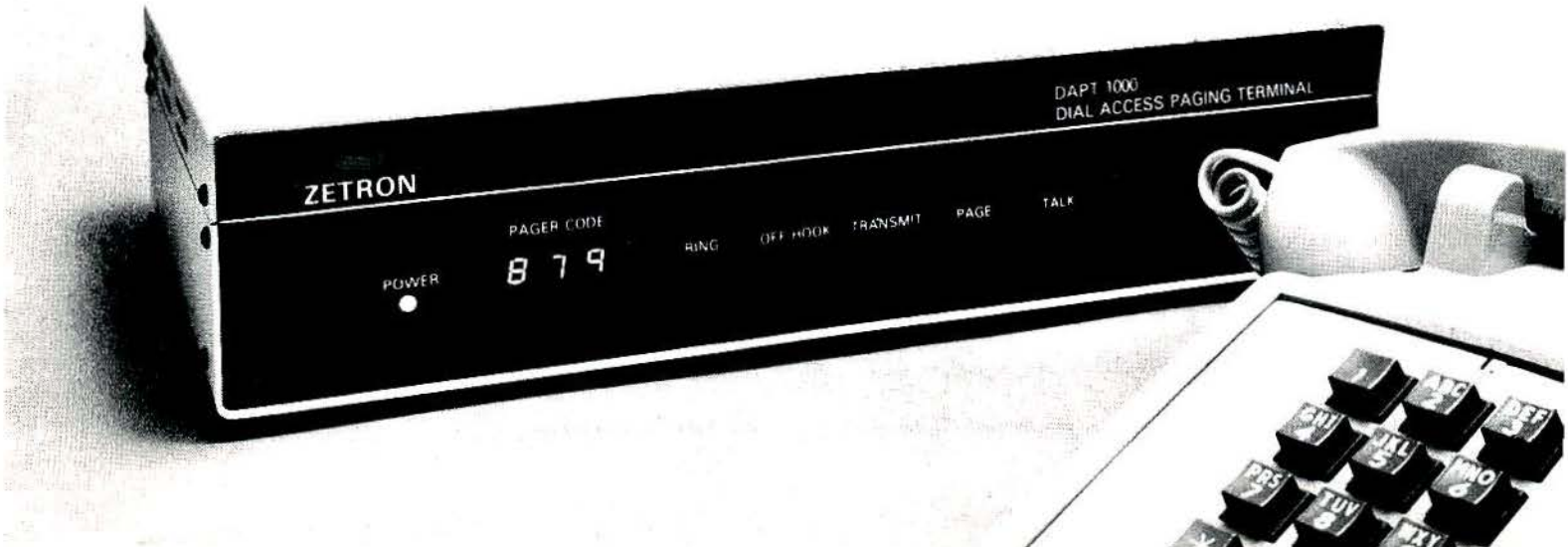


FCC Studies 'Spectrum Farming,' UHF Interservice Sharing

By Stephen J. Shaw
MRT Washington Correspondent

The Federal Communications Commission gave tentative approval in late November to two proposals intended to increase the amount of spectrum available to land mobile radio services.

The proposals are contained in separate reports issued recently by the FCC staff. The first, "A Framework For a Decentralized Radio Service" prepared by the Office of Plans and Policy (OPP), recommends the establishment of a new radio service with no technical or operational restrictions except those required to control interference.

The second, "Analysis of Technical Possibilities for Further Sharing of the UHF Television Band by Land Mobile Services in the Top Ten Land Mobile Markets," prepared by the Office of Science and Technology (OST), outlines the impact of additional land mobile allocations on UHF TV and low-power TV (LPTV) services in the most highly congested land mobile markets.

Mixing Services

"Spectrum Farming" was the characterization applied to the OPP plan by FCC Chairman Mark Fowler after hearing the proposal described by OPP Chief Peter Pitsch at the November 23 meeting. According to the plan, licenses would be granted for the proposed radio service with regard to the interference potential on other existing services only. Licensees would be free to offer any type of service deemed desirable — mobile radio, LPTV, UHF-TV and FM radio — or a mix of such services that would change as the licensee desired.

"This could be a very profitable business," Fowler commented. "You could change the mix of services like farmers rotate crops." The FCC chairman urged that the plan be tried in one city as an experiment. A formal Notice of Inquiry to solicit public comments on the proposal is expected to be issued early this year.

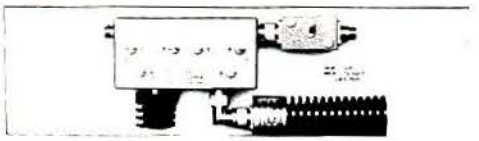
The plan for mixed service use could be applied to frequency allocations for UHF-TV, land mobile reserve, FM broadcast at 88 to 108 MHz, and in the presently unallocated L-Band at 1.5 GHz, according to Alex Felker, OPP electronics engineer and co-author of the proposal. The decentralized approach to allocations, said Felker, would allow development of radio services that are not dependent on specific, predetermined uses and possibly assist in the resolution of the battle now being fought by land mobile and LPTV interests for UHF spectrum. An LPTV station and a mobile radio service could utilize the same UHF channel in the same market as long as their interference contours, measured by their field strengths at the edges of their respective service areas, did not overlap.

Fowler: "You could change the mix of services like farmers rotate crops."

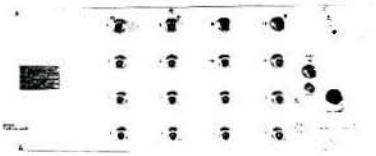
The plan also raises the possibility that a licensee could switch service offerings depending on the time of day. For instance, a licensee could run a mobile radio service during the business hours, then switch to video programming on the same UHF television frequency at night. Felker reports that he has already received an inquiry regarding the possibility of running a land mobile system during daytime hours, and an FM radio station at night.

As promising as the plan sounds, however, several drawbacks are apparent in attempting to replace the current method of block frequency allocations. First, manufacturers of land mobile radio equipment may be reluctant to tailor their equipment to fit the unique frequency requirements of specific markets. Secondly, opposition to the proposal may be forthcoming from those industry segments who currently have the targeted block allocations on a unshared basis, regardless of whether channels within those allocations are currently in use. Finally, there is a question regarding whether the FCC can effectively grant licenses that require a high degree of "engineering-in" and coordination with

R.F. Power Monitoring



IM Suppression Panels



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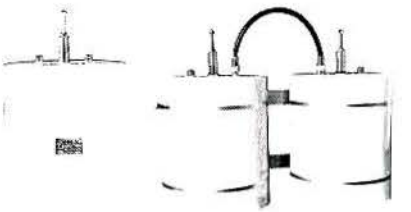

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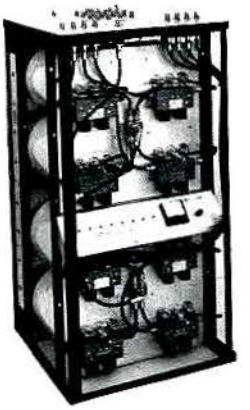

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other services that use the same frequencies in particular markets.

"Can the FCC handle an essentially decentralized service?" questions Felker.

UHF Sharing

The second report estimates the number of UHF channels that could be designated for land mobile use in specific cities with varying degrees of impact on licensed or allocated full and low power television services. The cities identified as the most highly congested for land mobile services and in greatest need of additional spectrum include Boston, Chicago, Dallas-Fort Worth, Detroit, Houston, Los Angeles, New York, Philadelphia, San Francisco and Washington, D.C.

The report, FCC/OST R83-3, outlined differing scenarios in which varying interference criteria was used to estimate the number of additional land mobile channels that could be gained in the UHF spectrum. The analysis was based on the technical approach to channel-sharing developed in Docket 18261, which permitted land mobile systems to operate on TV channels 14 through 20 in particular urban areas. The study concluded that if the interference-protection criteria developed in the rule making was strictly applied and assuming wide land mobile radio operating areas, the impact on broadcast service would be significant. In eight of the ten markets studied, this would require the deletion of TV allotments that are presently vacant but for which there are applications pending.

However, if the technical criteria for interservice sharing were relaxed and minimum service areas for land mobile systems were assumed, additional mobile radio systems could be accommodated fairly easily. In four of the ten markets, no existing, allocated or applied for broadcast services would be lost. In five others, only one or two LPTV assignments would be precluded.

Both studies may be obtained from International Transcription Services, Federal Communications Commission, Room 248, 1919 M St. NW, Washington, D.C. 20554. Telephone: (202) 296-7322.

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WARC Land Mobile Allocations Deferred

The Federal Communications Commission has deferred action with respect to plans to reallocate more UHF TV spectrum to land mobile users as it modified its rules, bringing them into conformance with 1979 World Administrative Radio Conference actions.

Although recent studies have projected land mobile needs to the year 2000, similar projections for the broadcast service are yet to be made.

Itinerant Frequency Plan Under Fire

The FCC's proposal to allow permanent operation by stations on land mobile frequencies presently reserved for itinerant use has drawn criticism from the Special Industrial Radio Service Association and others. SIRSA is the strongest critic, saying "This amendment is one of the most incredibly ill-founded proposals we have seen."

Mobile Relay Below 470 MHz Opposed

Motorola and the International Taxicab Association have replied to comments filed in the FCC's proceeding to allow the use of mobile relays (repeaters) by Part 90 licensees operating on frequencies below 470 MHz. Motorola said there is no viable way to coordinate paired frequency use necessary for repeater operation on frequencies below 450 MHz which are not presently assigned in pairs. The manufacturer said, "Mobile relays may be workable on the paired freqencies in the 450 to 470 MHz private land mobile band," and it would not object to repeaters on those frequencies.

The International Taxicab Association's reply comments indicate it remains firm in its opposition to unrestricted use of repeaters below 470 MHz "particularly as it would relate to the Taxicab Radio Service."

ACSB, FM Compared In FCC Laboratory Tests

An FCC laboratory study of ACSB communications systems concludes ACSB channels may not be intermixed with existing FM channels and remain completely inaudible on FM receivers. Yet the report suggests how ACSB might be considered for use in specific radio services.

Titled, "Amplitude Compandored Sideband Compared to Conventional Frequency Modulation for VHF Mobile Radio: Laboratory and Field Testing Results," the report was released by the Office of Science and Technology.

Cellular Exceptions Granted By Greene

U.S. District Court Judge Harold Greene granted some exceptions to the Modified Final Judgement in connection with the AT&T divestiture which may aid Bell operating companies in providing cellular mobile radiotelephone service. The exceptions ease restrictions on service BOCs may provide across inter-Local Access and Transport Area boundaries. The exceptions recognize calling patterns, existing facilities, toll switching center locations, economic efficiencies in addition to a possible wireline cellular disadvantage were BOCs restricted to LATA coverage and radio common carrier cellular operators not so restricted.

Nationwide Paging Jurisdiction Challenged

The National Association of Regulatory Utility Commissioners appears to stand alone in their challenge of the

FCC's preemption of nationwide paging regulation by the states. The federal agency maintains the Communications Act gives it grounds for regulating technical standards, entry into service, and rates to be charged by nationwide paging operators even though some pages may originate and terminate within a state. NARUC argues states have jurisdiction over technical and entry matters.

The U.S. Court of Appeals for the District of Columbia Circuit is hearing arguments in the case.

Information Asked Of Atlanta TV 69

FCC Mass Media Bureau Chief James McKinney has requested information from operators of WVEU Channel 69 in Atlanta in a letter sent to the broadcaster. Broadcasts from the station's transmitter, co-located with many 800 MHz land mobile stations atop the Peachtree Plaza, have caused interference to two-way radio operations and resulted in severe power reduction requirements during business hours for the television station.

McKinney asked the broadcaster for information about its ability to bear the financial burden of changing the frequencies of land mobile operators.

FCC Staff Report Recommends New Service On UHF-TV Channels

Flexible radio service is proposed in a staff report from the FCC's Office of Science and Technology released in late September. Not an official report, "A Framework For a Decentralized Radio Service" details a new radio service without any technical or operating restrictions beyond those necessary to control interference. Licensees would be free to offer entertainment programming, land mobile, or other services.

The study recommends using vacant UHF-TV channels, including those that are so-called "taboo" channels. Alternative spectrum includes land mobile reserve, aeronautical satellite allocations and new assignments in the FM broadcast band made available by Commission action on Docket 80-90.

SMR Loading Change Petitioned

Smith Communications Systems, Inc., wants the FCC to change its SMR loading rules to provide an "alternative measure of loading for specialized mobile radio systems to correct the inequities of the present rule requirements."

Smith has undertaken a traffic study which indicates most of the time available on a trunked system will be filled when approximately one third of the sytem's mobiles are equipped to interconnect with the public switched telephone network. According to the company, that level reflects about half the number the FCC presently recognizes as minimum loading for an SMR to retain all its authorized channels.

Freedom Recommended For Land Mobile Spectrum Use

Land mobile spectrum users would be given "more freedom to choose how best to utilize" the spectrum, under three recommendations advanced by the FCC's Office of Plans and Policy. The suggestions are contained in a staff report, "Implementing New Technology in the Land Mobile Radio Service."

The study recommends developing definitions of "spectrum rights" of signal strength and protection from interference, flexibility to use new, spectrum-efficient technologies, and the "freedom to profit" from the resale of spectrum saved through application of new technology.

System ID Numbers Asked For Cellular

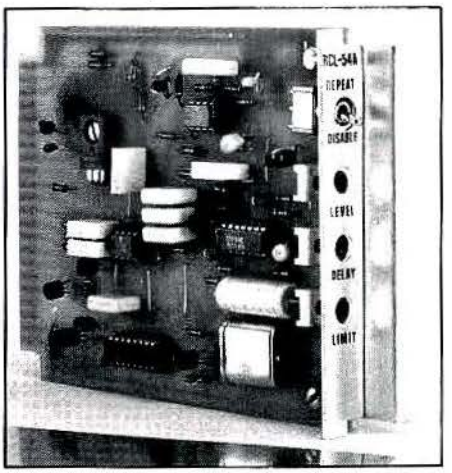
The Electronics Industries Association recommended the FCC assign system identification numbers (SID) to individual cellular systems. The association suggests "the system number (bits 0 through 12) be assigned at the time of granting of construction permits." Assignments would be published using standard notification procedures. The SID numbers would be used to determine whether a call were made by a system's home subscriber or a roamer.

new products

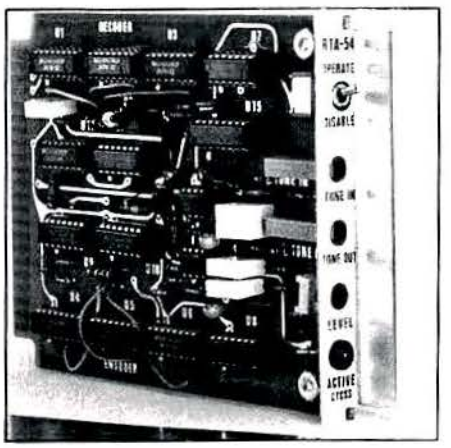
Modules Build Base/Repeater Station

The WR 90 series of base/repeater stations is a fully integrated, modularized family of components from **WR Communications** intended to provide simple, easy system design. The basic cabinet housing a simple local control can be converted to provide DC remote, repeater application, cross band or a multiple station configuration. The company says the use of solid state cards and modules that are conservatively designed provide high reliability and easy interchange.

Electronic interface to operate a radio transmitter and receiver in a radio-repeater configuration is provided by the RCL-54A Repeater Control. The circuit



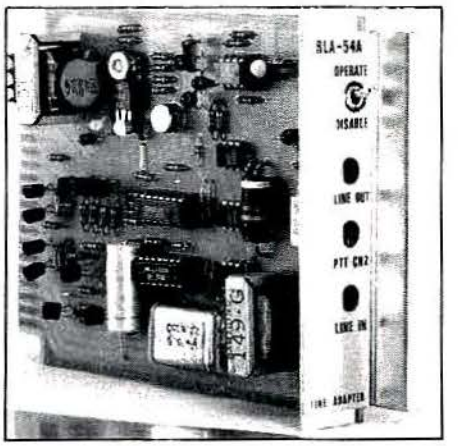
board plugs into a 22-pin printed circuit edge connector designed for quick removal. The control has provision for continuous tone coded squelch system (CTCSS) operation with an audio high pass filter to remove the input tone from coupled audio. It allows newly generated and leveled tones to be inserted. A 200 kHz clock generator is included, capable of driving a clock bus for multi-tone systems with synthesized tone encoder-decoders such as the company's RTA-54. An on-board front panel switch disables the repeater transmit function during tests.



The RTA-54 is a programmable CTCSS tone encoder-decoder that uses an external 200 kHz reference clock provided externally. Up to 16 RTS-54 cards can be operated from a single RCL-54A. RTA-54 cards plug into 22-pin printed circuit edge connectors.

The synthesizing encoder and decoder are independently programmed and tuned so the input tone frequency may differ from that of the output tone. Tone frequencies are programmed on the circuit board using four wires. The encoder output tone is enabled onto a tone bus by the decoder. When the decoder responds to an input tone, a front panel light emitting diode (LED) glows. The decoder and "active" light continue to function when the front panel "disable" switch is used to deactivate the repeater base station.

Interface to allow remote operation of a radio transmitter and receiver on a two-wire line with DC continuity is provided by the RLA-54A DC Line Adapter. The circuit board plugs into a 22-pin printed circuit edge connector. The line adapter provides for two-wire or four-wire (duplex) operation, transmit channel selection F1 or F2, and receive channel selection F1 or F2/CTCSS monitor function can be used in lieu of receive channel selection. Three jumpers pro-

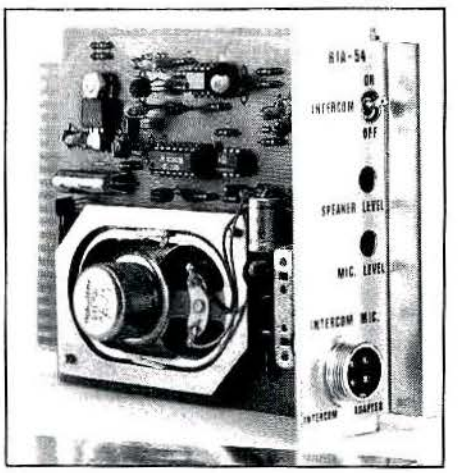


gram the functions. A time-out timer circuit disables the transmitter line keying after six minutes of continuous line keying. The timer resets immediately when line keying stops.

Pre-emphasis is used in the line receiver to allow transmitter modulator connection. An on-board front panel switch disables the line-keying function for adjustment or testing.

Facilities for intercom in a radio system equipped with a RLA-54A DC Line Adapter are provided by the RIA-54 Intercom Adapter. It also has E and M signaling circuitry to interface the radio with an external communications link such as a microwave relay.

The intercom allows communication



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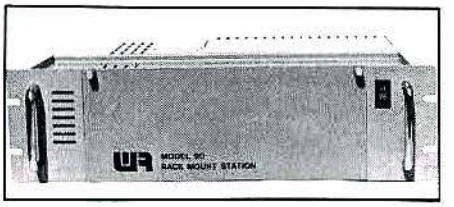
between the radio and remote control positions using the two-wire line normally used for remote control. A front panel switch turns off the intercom when not in use. The circuit board plugs into a 22-pin printed circuit edge connector. It has an on-board speaker with a front panel level control. The speaker amplifier uses a compressor to reproduce all line signals at about the same volume and with low distortion. The intercom uses a WR Communications MC-30 handheld microphone plugged into the front panel jack. The microphone PTT button is used to place the intercom into the "talk" mode.

Any of the 33 EIA CTCSS tones or, alternatively, over 400 in-band burst tones from 400 to 2500 Hz may be used with the RTB-54 programmable tone encoder or decoder. Provision is made for a latch circuit with a delayed reset. A quartz-crystal time base and a programmable-period synthesizer are used. The tone period is programmed with an on-board binary switch. A tunable band-pass filter is used to filter the input and output. A high-pass filter is included for CTCSS applications.

Audio and PTT interface with up to three radio terminals is handled by the RTL-54 Trunk Adapter. Up to six different interface programs may be selected by external circuits such as tone decoders. Trunk Adapter inputs are the outputs of RCL-54A Repeater Control cards or their equivalents. Trunk Adapter outputs are connected to terminal transmitters.

WR 194 transmitter and receiver modules also fit the 5¼" rack cabinet and operate from either 110/220 VAC or



13.6 VDC. The transmitter module has a power output of four watts which may be amplified at intervals up to 120 watts with WR 95 series linear amplifiers. Contact: **WR Communications Inc.,** 437 So. 48th Street, Tempe, AZ 85281 or 1655 West 3rd Ave., Vancouver, BC, Canada V6J 4V7 or R.S. #240.

Base Repeater For 800 MHz Trunked, IMTS, Conventional

Kokusai's new 800 MHz base/repeater station line is 100% solid state. Space saving configurations permit a 5-channel system in 3 cabinets, 10 channels in 6, 15 channels in 8, and 20 channels in 11 cabinets. Heavy duty power supplies are continuous-duty rated. Features include centralized metering, automatic power control, channel inhibit, automatic load control and alarm indicator and terminal strip.

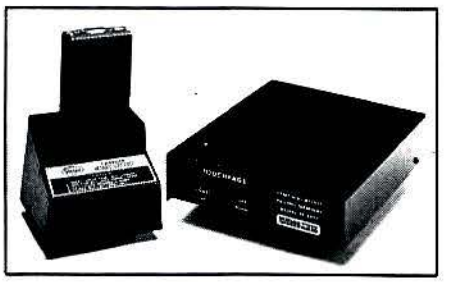
Interface boards are available to mate with IMTS terminals. Contact: **Kokusai Electric Co. of America,** 363 Coral Circle, El Segundo, CA 90245 or R.S. #239.

Pager Has Dial Access Decoder, Terminal Sends DTMF Tones

Sonar has introduced a 2-digit DTMF decoder in a pager. Designated Tone Decoding Option T2, it is available in Sonar's X-Rē™ series regular pager and Senator™ pager. The decoder is the first component of an integrated, selective calling system called Touchpage™. The DTMF decoder in the pager allowed the design of a terminal that recognizes Bell System codes, greatly simplifying the dial-access paging terminal.

The TP-2997 Touchpage Terminal is the dial-access paging terminal used to call pagers with Option T2. The unit is approved by the FCC for Part 68 for direct telephone interconnect. The TP-2997 has a suggest retail price of $200.00. An optional, field-programmable security lock module, SL-3003, prevents unauthorized system access, and has a suggested retail price of $150.00

The Touchpage System allows selective calling of pagers and other signaling



devices from any Touch-Tone® telephone, in-plant or out. Any source of Touch-Tone signals, such as a DTMF pad on a portable two-way radio, or a mobile Touch-Tone microphone or handset, in addition to the telephone network, can be used to activate the system.

For technical details on the Touchpage system, see Richard Abrahams' feature article on page 54 of the November 1983 ***MRT***.

The Busy Lock-Out Assembly, BL-3004, is an accessory to the TP-2997 Touchpage Terminal. This assembly will recognize an active channel, such as on a repeater, and not allow a page to be transmitted. This option allows DTMF pagers to be used on Business/Industrial frequencies with existing two-way traffic. Small RCC operators who cover isolated areas that do not warrant the high fixed cost of conventional paging terminals may also use the system.

The BL-3004, when interfaced with either a repeater transmitter's push-to-

talk line or a control station receiver's squelch line, inhibits the Touchpage Terminal's operation when prior use of the network is detected.

The Busy Lock-Out may be interconnected to the TP-2997 to provide two distinct modes of operation. When the channel is active, the terminal answers the telephone and gives a busy signal, or when the channel is active the terminal does not answer the telephone.

In the first case, a properly working telephone line and terminal is positively indicated, but in certain areas measured rate telephone line charges may be incurred. In the second case, measured telephone line charges are avoided.

The BL-3004 mounts inside the TP-2997 Terminal. Existing units may be field-retrofitted. This option is available for $50.00. Contact: **Sonar Radio Corp.**, 3000 Stirling Road, Hollywood, FL 33021 or R.S. #238.

Protocol Support, Network Analyzer

A new interface kit which allows the HP 4955A protocol analyzer to physically connect to an X.21 public network has been introduced by **Hewlett-Packard.**

The interface kit, HP 18138A, provides a cable with X.21 15-pin connectors for use with HP's RS-449 interface pod, the HP 18136A, for the physical connection. Also included in the kit is the display software which allows simultaneous viewing of both character-oriented protocols (COPs) and bit-oriented protocols (BOPs).

High-performance network analysis for bench use or automatic testing is possible with Hewlett-Packard's new 3577A network analyzer. This analyzer expands testing capabilities for device characterization in the R & D lab and production test.

The 3577A features precise analog design, advanced digital-signal processing and microprocessor control with extensive internal firmware. High accuracy and resolution over the 5 Hz to 200-MHz frequency range are now available in a single product.

Measurements can be made over the analyzer's 100-dB dynamic range with up to 0.02-dB and 0.2-degree dynamic accuracy. In the 1-Hz resolution bandwidth, critical low-level measurements can be made with -130 dBm sensitivity. The display marker shows points of interest to 0.001 dB, 0.005 degree and 0.001-Hz resolution.

The HP 3577A network analyzer is $23,500. The HP 35677A (50-ohm) and HP 35677B (75-ohm) S-parameter test sets are $3,500 each. Delivery is estimated at six weeks ARO. Contact: Inquiries Manager, **Hewlett-Packard**

Company, 1820 Embarcadero Road, Palo Alto, CA 94303 or R.S. #236.

Isolators/Circulators Introduced By Sinclair

Sinclair Radio Labs has introduced the new "I" series of compact, high performance isolators and circulators for applications in the 1300 to 1600 MHz bands. The I5110A series features typical insertion loss of 0.25 dB and isolation of 35 dB over a 100 MHz bandwidth.

The units are available in a variety of load terminations to meet diverse system

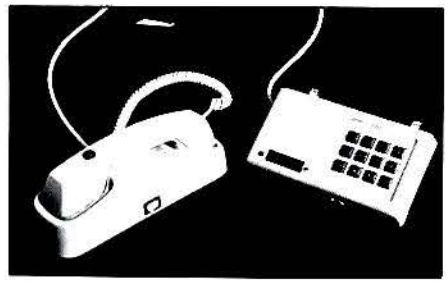
requirements for VSWR protection and intermodulation control. The "I" series is designed for temperature compensation to assure high isolation and low insertion loss performance over the full operating temperature.

"PC" series isolator panels are also available combining the "I" series isolators with various terminations and second harmonic filters to provide compact, rack mount units for intermodulation control in existing base stations. Contact: **Sinclair Radio Laboratories Inc.,** 14614 Grover Street, Suite 210, Omaha, NE 68144 or R.S. #237.

Universal Mount Mobile Telephone

The availability of a new universal mount, full featured mobile telephone, QCU 8200 has been announced by **Global Telerad.** The new unit features the control keypad mounted on the vehicle visor in the 'up' position, the handset can be secreted in the glove or console box, or be mounted unobtrusively on or under the dash to help assure security from vandalism.

The unit operates in standard DTMF signaling mode, and is available in simplex, half duplex or full duplex. The



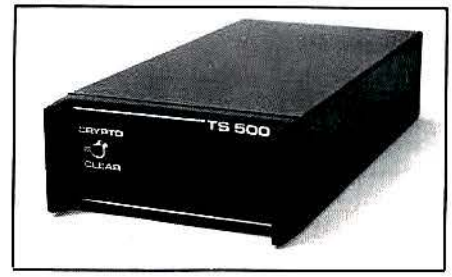
microprocessor based control head can be used in either conventional or multichannel 800 MHz, TSMR or LTR systems. With addition of the company's SMART/IMTS module, the unit can be used in conventional RCC systems. The unit will interface with all popular transceivers, giving the user access to the landline telephone network while preserving two-way radio dispatch functions. When the vehicle is unattended, the QCU 8200's voice answering module instructs the caller to dial in a number. The unit will store five such messages for callback at the mobile telephone customer's convenience.

Other features include an illuminated keypad for accurate nighttime dialing, an 8-digit LED integral display showing numbers dialed, channel selection and information messages. The microprocessor also provides last number redial, on-hook dialing, speed dialing of up to nine stored, frequently called numbers, store and forward calling, memory protection, channel busy lockout, and overdial to access networks other than AT&T. Contact: **Global Telerad, Inc.,** 410 Jackson St., Mankato, MN 56001 or R.S. #235.

Time Division Voice Scramblers

P.P.S. Electronics has introduced the Telsy Crypto Systems series of professional voice protection system models for mobile and portable speech encryption. The TS 500 series has models for mobile, portable and master syncronization. The time division method achieves a high level of security in a narrow bandwidth and will work with all types of radio units.

Except for the input and output programmable interfaces, the system is fully digital. Over one million code programs



are available. Contact: **P.P.S. Electronics Corporation,** 101-10 Foster Avenue, Brooklyn, NY 11236 or R.S. #234.

DTMF, Digital Ruggedized Encoders

Tex-Tel has introduced two new ruggedized DTMF and digital (Digi-Touch—12 bit FSK) encoders. Large button, full-stroke key pads with special seal and heavy cast aluminum case make both units dust proof, splash proof and virtually abuse proof. Both DTMF and

digital models provide automatic PTT with adjustable pre-data timers to assure radio system compatibility. Illuminated keyboard available. Contact: **Tex-Tel Laboratories,** 812 Brentwood, Austin, TX 78757 or R.S. #233.

Remote Control, Status Monitor

Monroe Electronics' 6002 telephone remote control and status monitoring system permits monitoring and control of

unattended equipment over a standard dial-up telephone line from any telephone. The 6002 contains an integral FCC registered coupler for direct connection to the telephone line.

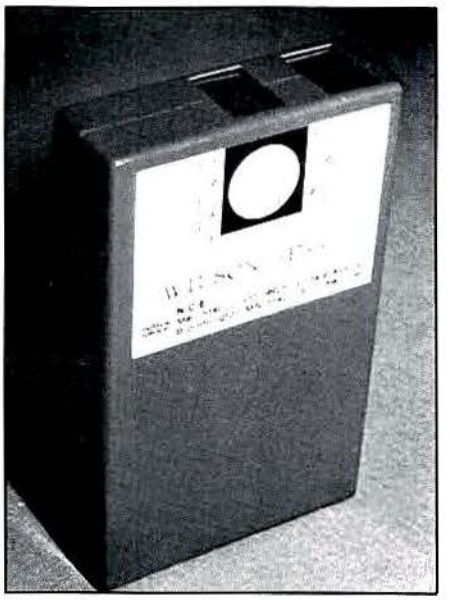
Touch-Tone® commands latch or momentarily close any of six independent relay outputs. Additional commands cause the 6002 to respond with audible tones indicating the open or closed condition of each relay output and each logic status input.

An audio input is provided to allow telephone monitoring of an audio source at the remote site. An internal test tone generator responds to a Touch-Tone command. An internal timer automatically disconnects the 6002 after a period of no activity.

The 6002 is housed in a gray, wall mount enclosure. Standard barrier strip terminals are used for easy installation. An outlet mounted power supply is provided for operation from 117 VAC, 60 Hz. Contact: **Monroe Electronics, Inc.**, 100 Housel Ave., Lyndonville, NY 14098 or R.S. #232.

Replacement Battery For Handheld Radios

N.C.E. has introduced a new Power Group battery compatible portable radios made by Yaesu, Uniden Force, Wilson and others. The new product includes repairable features of other Power Group designs. Price per unit is $23.00 for up to

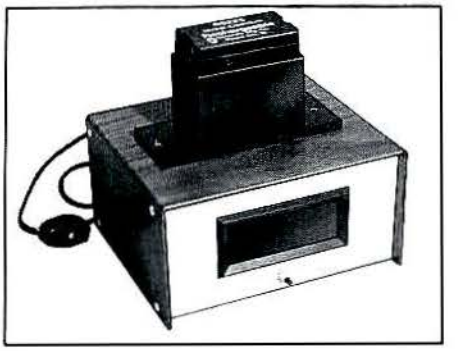


nine units and $19.00 each for 10 or more. Contact: **N.C.E.** Mail Station 331, 9925 Lyndale Ave. So., Bloomington, MN 55420 or R.S. #231.

Microprocessor Programmed Ni-Cad Battery Analyzer

The **Alexander** TA1500 battery analyzer utilizes a microprocessor programmed especially for nickel cadmium batteries. The analyzer first fully charges the battery, followed by a deep discharge to 1 volt per cell. At this point, it computes the actual capacity of cycle and reads out in 'milliamp hours' (MAH). No monitoring is necessary because the reading remains while the battery is completely recharged. The TA1500 is available for most nickel cadmium batteries.

Special applications such as single cells and high capacity packs can be

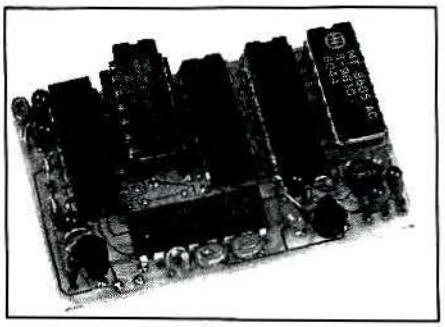


accommodated. The compact TA1500 is built for a specific voltage and capacity range. The unit must be returned to the factory to be changed from one battery type to another. Contact: **Alexander Manufacturing Company**, Box 1645, Mason City, IA 50401 or R.S. #230.

Subminiature, Sequential DTMF Tone Decoders

Data Signal's subminiature DTMF decoder MTD-200 accepts transmission of all 16 standard DTMF tones. The small size makes it ideal for handheld or mobile radios with severe space limitations.

The board consists of a highly accurate crystal controlled DTMF band-splitting filter and DTMF decoder. A diode matrix PROM-programmable chip holds the



user-specified code. Factory coding of the PROM is available or users may program it in the field by using a field programmable coding plug.

When the MTD-200 receives a properly sequenced code, it sends an alert tone to notify the mobile that a call is in progress. The unit's digitally synthesized tone decoder provides low current drain, high frequency stability,and allows operation over a wide temperature range.

Capable of decoding a one to eight digit sequence, the MD-803 sequential DTMF mobile decoder can be used with most radiotelephone systems. The MD-803's crystal-controlled DTMF decoder and tone filter offer low current drain, a high resistance to radio frequencies (RF), and a wide temperature operating range.

The MD-803 has a unique calling capability that allows it to respond to elongated digits. The digits can be assigned on the first digit of a call as well as most other digit locations. This provides unlimited capability of All Call, Group Call, and Sub-Group Calls.

Positive command reset comes standard. It allows the caller to extinguish the call light and remute the speaker. The MD-803 also offers an acknowledgement transponder and a call light and audible alarm. The transponder automatically energizes the transmitter and sends a tone back to the caller giving the mobile status. Upon receipt of a wrong digit the decoder is automatically locked out and remains reset until the start of a new sequence.

The call light and audible alarm notify the mobile that the MD-803 has been properly addressed. A relay will activate the vehicle's horn or lights if the driver is away from the vehicle. Complete with mounting bracket, the MD-803 is intended for installation in vehicles with a 13.6 volt electrical system. Contact: **Data Signal, Inc.**, 2403 Commerce Land, Albany, GA 31708 or R.S. #222.

5 Tone Sequential Encoder-Decoder

American Microsignal's newest miniature five tone sequential encoder and decoder is especially designed for use in hand held radios. Fully field programmable, the AMC Model 555 will decode any combination of two, three, four or five tones in sequence of standard

and special tone code formats including CCIR, ZVEI, and NATEL tone frequencies.

The encoder portion automatically transponds or may be activated by the TX key line for vehicle or number identification or "answer back." For the OEM, the hybrid Module 556 is available ready for PCB insertion. For full underdash function, the Model 580 supplies call-light/reset, audible or horn honk capabilities and a 10 position status selector.

AMC says the small size makes in-board installation easy, even in many handheld radios, making this type of selective signaling very practical. Digital filtering has been built-in, assuring excellent performance under adverse signal-to-noise ratios. The filtering is designed with a wide dynamic range and accepts tone amplitude down to 150 mV RMS.

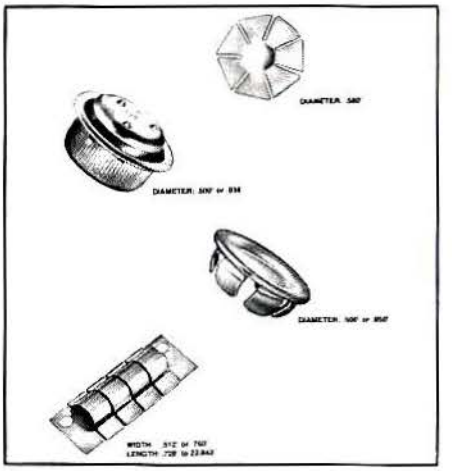
The 555 may be employed in two-way radio selective calling or in telemetry telephone or security applications. Contact: **American Microsignal Corporation,** 8431 Monroe Avenue, Stanton, CA 90680 or R.S. #228.

Grounding Assemblies

Instrument Specialties has announced the introduction of new electrostatic discharge and grounding products. The new parts allow grounding of high voltage static discharge with discrete points of contact.

These new assemblies combine optimum contact force with a minimum of stress on the contact. The grounding assemblies are precision manufactured from beryllium copper with all its inherent advantages. A complete spectrum of platings is available to ensure galvanic compatibility.

Off-the-shelf assemblies include the mushroom, with a plastic push rivet which mounts through a 0.250 inch diameter hole. The pop-up is a brass spring loaded assembly in a serrated cup for easy snap-in mounting. The brass contact plate is used with both the mushroom and pop-up assemblies as a mating surface. Grounding bars can be mounted on chassis and cabinet frame components by riveting, heat staking, or by using common hardware. Special designs engineered precisely to meet individual requirements are available with a minimum of lead time.



More detailed information on these products is available in Instrument Specialties' new manual, "Guide to Interference Control," available free upon request. Contact: **Instrument Specialties Co., Inc.,** Delaware Water Gap, PA 18327 or R.S. #226.

Leather Cases Fit Radios, Pagers

Barnhill Brothers has introduced a new product line of leather radio and pager cases. The Key Kases are designed

for precise fit and easy access to units. Key Kases can be custom-made in various colors and materials. Contact: **Barnhill Brothers Co.,** 27 North Prince Street, Lancaster, PA 17602 or R.S. #229.

Bus Service Efficiency Enhanced By Data Interface

Automatic ticket machines are interfaced with mobile radios via a data link between the ticket machine and the digital signaling module of a **Pye Telecom** mobile radio. Valuable information can be transmitted to headquarters control automatically.

While bus drivers have only to issue tickets as before, their dispatchers can be fed information about the identity of the bus, its location, how full it is and whether it is on schedule. The information can be stored in the computer and retrieved later or be used immediately, either as a hard copy print-out or on a TV monitor screen.

At a glance, dispatchers can see if buses are being bunched by traffic or weather conditions, running early or late, and know exactly where they are on their route. It is only then that the radio is used in its speech mode to give assistance or instruction to the bus driver.

Pye Telecom's two new mobile radios, designed specially for users like bus operators and the fuel and power industries, have all the features required to make very sophisticated vehicle route management a simpler and more efficient process. This has been achieved by the cooperation of Control Systems of Uxbridge and Pye Telecom in the development of a suitable data interface between the "Farespeed" electronic ticket ma-

(Continued on page 78.)

Standard Communications is the biggest opportunity going in land mobile radio.

That's saying a lot, but as any of our dealers will tell you, Standard has what it takes to really compete in the rapidly expanding land mobile business radio market.

handhelds, a new base station that fits any office decor, and our PG50 the industry's only pager offering tone, voice, digital display or any combination of the three in a single unit.

And when cellular becomes a factor, we're more than ready.

FM91 microprocessor-controlled, 120-channel mobile

Our product line is precisely that, the right mix of products enabling you to take on any application. We now offer mobiles ranging from economical 2-channel crystal-controlled models up to our newest high tech, microcomputer 120-channel FM900 Series. Add to that our proven

We back our dealers to the hilt with a support package including lead-producing ads and sales aids, Co-op, financial management, special discounts, and the kind of field service and training geared to produce results.

FX60 2-channel base station with digital clock, intercom

PG50, the industry's only HSC pager offering tone, voice and digital display in a single unit.

If you would like to join the fastest-growing land mobile radio team in the country, call us for a copy of our dealer planning guide "The Business Radio Opportunity" toll-free 800/421-2916 (in California 213/532-5300).

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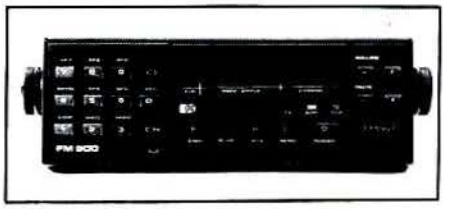


chine and Pye FM 900 two-way radios.

Pye's FM 900 and MX 290 radios represent a generation of two-way radios designed for data transmission and telemetry as well as speech. Both feature major developments in solid state circuitry which ensure high reliability and minimize maintenance down-time.

The FM 900 is an "intelligent" frequency-synthesized mobile radio incorporating a large capacity microcomputer. Built-in facilities give access to a wide range of sophisticated software options, making the radio suitable for interfacing with fully automatic vehicle location and monitoring systems, without increasing its operational complexity. The microcomputer is able to "handshake" with its equivalent in the electronic ticket issuing machine over a standard data link such as an RS232.

The MX 290 series two-way mobile radios also incorporate frequency synthesizers and offer up to 250 channels, with a choice of conventional or keypad control. Designed on a modular basis, these mobiles give users a wide choice of options and facilities, enabling complete systems to be tailored to a customer's exact requirements from a range of standard products. Contact: **Pye Telecommunications Ltd.**, St. Andrews Road, Cambridge, England CB4 1DW or R.S. #227.

Motorola Reduces Mobile, Portable Prices

Motorola has announced price reductions for portions of its mobile and portable radio lines. Specific product prices in many frequency bands and power levels have been lowered.

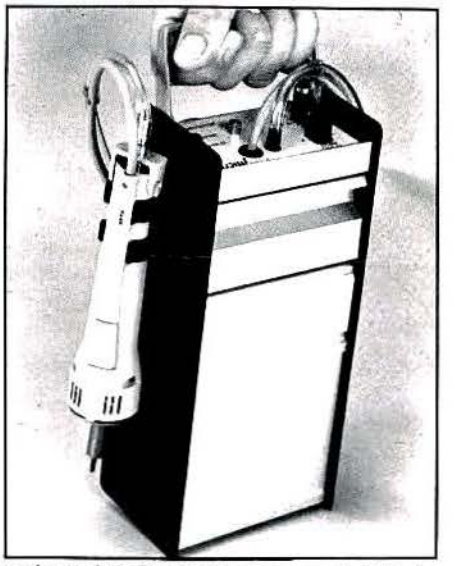
Both conventional and trunked mobile radios have been reduced, some conventional models having reductions of 12% to 14%. The conventional mobile products include Syntor X, Syntor, Mitrek, MCX100, Motrek, Maxar 80 and Moxy. The trunked mobile units are Mostar and Traxar.

Portable price reductions of most models range from 11% to 23%. The low tier HT90 and HT440 have an average price decrease of approximately 15%. In the high tier MX300 series portables, all one and two frequency models, in the 150 MHz and 450 MHz band, and all 800 MHz radios have been lowered. Motorola's smallest portable, the Expo, has also been marked down. Contact: **Motorola Inc.**, Communications Sector, 1301 E. Algonquin Rd., Schaumberg, IL 60196 or R.S. #225.

Portable, Bench Soldering, Desoldering Systems

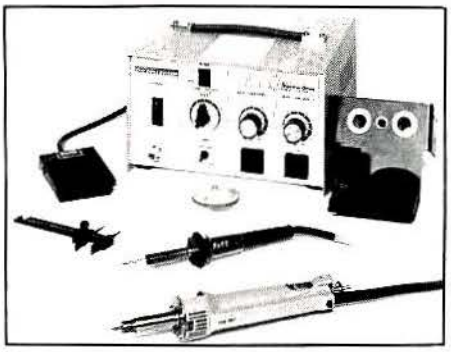
Pace's new Micro provides a self-contained power desoldering and soldering system that can be used anywhere electronic equipment needs to be repaired—in depot, in mobile vans, in remote field service centers, or on-site.

The Pace Micro warms up in one minute. Desoldering and soldering are accomplished with a single handpiece with a finger activated vacuum. The Micro provides spike-free MOS safe operation



and precise tip temperature control high reliability repair. It operates on AC and 12 VDC sources.

Pace's SX-301 is a completely self-contained, spike-free power desoldering and soldering system. The system contains two variably controlled polarized outputs for temperature level control,



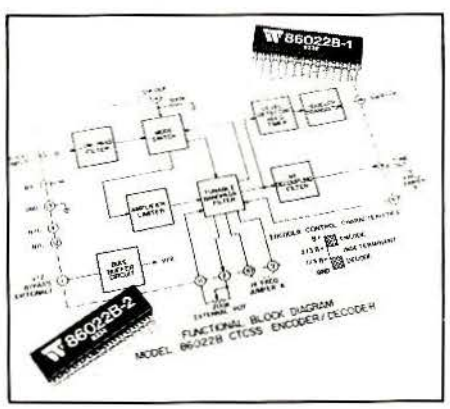
zero power switching for safe ESD operation, a fast-rise vacuum pump with fixed vacuum outlet, a variable pressure outlet for pressure and hot-air jet operations and easy foot pedal control switch.

The unit is corrosion proof and is shock mounted for vibration isolation. Also featured is the No Clog dual path solder extractor. Contact: **Pace, Incorporated,** 9893 Brewers Court, Laurel, MD 20707 or #223.

Hybrid CTCSS Encoder/Decoder Tunes 50 to 260 Hz

The 86022B is a new generation of CTCSS encoder/decoder from **White Technology** and is frequency tunable from 50 to 260 Hz. Using a single fixed resistor, the device may be set to any of the distinct CTCSS tones, including the 37 EIA frequencies. Any tone frequency between 50 and 260 Hz may be tuned using an external potentiometer.

The encoder/decoder provides complete CTCSS capability of new or existing communication equipment. State-of-the-art thick film hybrid construction is utilized to combine a low-pass filter, a comparator, a switch, a bandpass filter, and four other devices in a very small ceramic package.



The use of micropower components and the small physical size make the 86022B suitable for battery powered, handheld and mobile transceivers. It may also be used for multitone encoding and decoding, using solid-state switching of the tuning resistors. Current consumption is typically 2.7 mA at 7.5 volts, while supply voltage requirement is 4 volts to 15 volts.

Temperature stability is less than 50 ppm per degree of Centigrade. Operating temperature range is –30°C to +70°C. Two models are available. The 86022B-2 time is typically 200 msec. Both have a typical decode mode turn-on time of 50 msec, and a typical encode turn-on time of 10 msec.

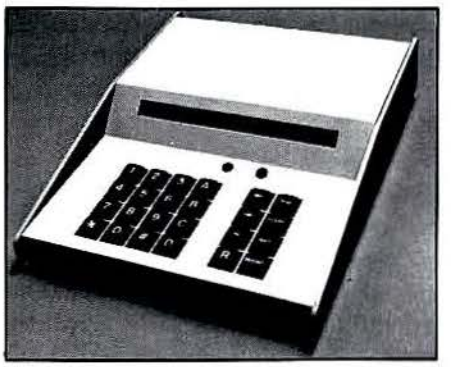
In the decode mode, the switch output of the device is ground until a signal is received. The tone input results in an open collector at the switch output. This unsquelches the receiver as long as the tone is present. During encode, the de-

vice generates the precise tone signal at the output for modulating the transmitter.

The 86022B is readily available in volume production with delivery from stock to 4 weeks. The price for either model in quantites of 100 is $32.45 each. The 86022BE, an encoder only, is $14.95 each in quantities of 100. Contact: **White Technology, Inc.,** 4246 E. Wood Street, Phoenix, AZ 85040 or R.S. #224.

Operator Console For Paging, Answering Service

BBL has introduced the Opcon-Plus. Originally designed to be used as an operator input device for tone only and



numeric input pagers, the Opcon-Plus now has applications for both paging operations and telephone answering services.

For a paging operation it can be used to generate the necessary DTMF tone padding to signal the pager. Since it can be connected to the main frame computer system, it displays any information related to a particular subscriber on a liquid crystal screen. In addition, this allows the operator to visually verify the information prior to sending it.

One of the features of the Opcon-Plus enables an operator to transmit not only the ten numeric signals, but also the letters A, B, C, and D. Currently, these letters are being used on some numeric pagers on the market.

Besides its uses with pagers, the unit can offer a variety of services to a TAS operation. By using either semi-automated or manual operation position, the Opcon-Plus can be used in conjunction with the BBL voice retrieval system (VRS). The operator can patch a call into the VRS merely by pushing a button. The call is immediately transferred to the VRS, where the caller's message can be recorded by the VRS just as it was delivered to the operator.

The Opcon-Plus also allows the operator to transmit DTMF code to the VRS, so that the system can be remotely accessed. For example, when an incoming caller is dialing from a phone that does not have DTMF, the operator can interface for the caller and enter the necessary DTMF code. In addition, the operator may distribute messages to more than one VRS mailbox. Contact: **BBL Industries, Inc.,** 2935 Northeast Parkway, Atlanta, GA 30360 or R.S. #220.

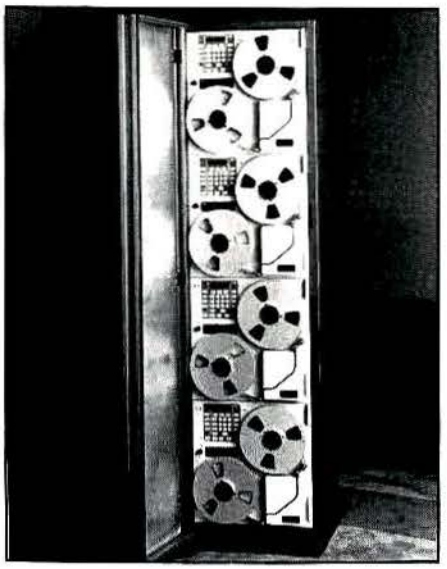
RF Power Amplifier

Trilectric's new RF power amplifier for repeater applications is designated the A-6100UR. It produces 70 to 100 watts output power when driven with 2 to 6 watts input. Operating in the 450 to 512 MHz frequency spectrum, the A-6100UR utilizes an advanced stripline design which allows operation within a 20 MHz bandwidth with no degradation in power output. The A-6100UR features a sealed aluminum alloy case construction for reduction of RFI. Mounted on a 19" x 10" rack mount heatsink, the A-6100UR is capable of operating at a continuous duty cycle without the need for a cooling fan. Standard RF connectors are SO-239 with optional N-connectors. Contact: **Trilectric** or R.S. #219.

Recorders Feature Building-Block Modules

Magnasync® has announced a new record/reproduce module to complete the Specialist™ series of computer controlled communications recorders. Equipment may be configured to suit individual applications, without unnecessary duplication of functions.

Four complete modules can be housed in a single cabinet. The new units offer up to 40 channels per deck, or up to 160 record/reproduce channels. Full microprocessor control via a touch-sensitive



membrane panel provides simplified operation, built-in time code generator/reader with automatic search, fail-safe features, self-diagnostics and programmable transfer between decks. Contact: **Magnasync/Moviola Corporation,** 5539 Riverton Avenue, North Hollywood, CA 91601 or R.S. #218.

Computer Controlled Encoder/Decoder

STC has introduced the MED-100 tone encoder-decoder for paging systems, two-way radio, cordless telephone and data transmission. Two-tone, five-tone, DTMF and FSC signaling protocols are accommodated for ZVEI, CCIR, NATEL and RS-232C specifications. The MED-100 incorporates a Z-80 microprocessor with battery backup for RAM and real time clock functions.

Tone sequences may be field programmed. One or two-way tone and voice, digital and display paging are handled via tone or binary codes provided along with busy channel monitoring, automatic station ID, and full mobile frequency coverage.

Computer interface with RS-232C has telemetry and security applications, vehicle fleet control provision, and data transmission ability. The MED-100 has a uni-directional microphone mounted on a flexible gooseneck, a six-watt audio amplifier, and external connections for additional microphones and speakers. Accessories include remote control, intercom and PBX or PABX interfaces and an acoustic modem. Contact: **STC Electronics,** 161 Brugsesteenweg, 8500 Kortrijk, Belgium, Europe or R.S. #217.

Controller Price Reduction

The **Tektronix** 4041 instrument system IEEE-488 controller US base price has been reduced to $3995, a decrease of 20% from its original price of $4995. In addition, Tektronix is making available three new memory configurations—128K, 256K, and 512K bytes—priced at $700, $1200, and $2200 respectively. This is about 70% less than the previous price for the instrument's memory configuration which was based on 32K byte increments.

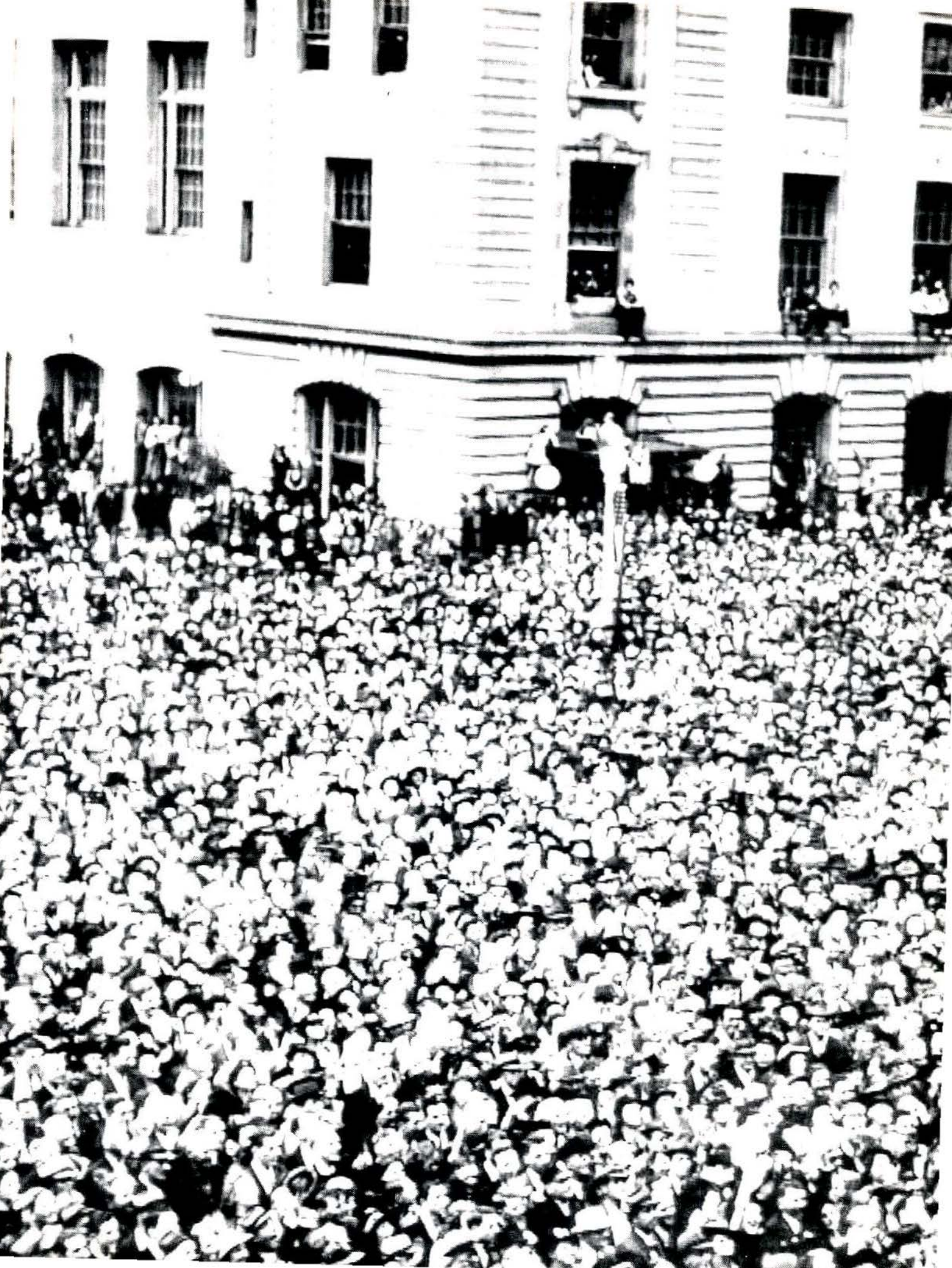
The price reduction was brought about by the deletion of the 4041's 32K byte increments and the replacement of the controller's 16K RAMs with 64K RAMs. "The price reduction and new memory sizes positions us more effectively in the instrument controller market," states Jim Jadin, marketing product manager, "without sacrificing the 4041's performance or reliability." Contact: **Tektronix, Inc.,** P.O. Box 500, Beaverton, OR 97077 or R.S. #216.

LITERATURE

Full Color Catalog Of Communications Batteries

Multiplier has announced the availablility of its new 12-page full color catalog for communications batteries. Catalog #850 lists and cross references over 300 nickel-cadmium, alkaline and mercury batteries for handheld transceivers, pagers and other applications.

The new catalog features full color photographs of Multiplier's battery products, as well as technical discussions regarding the high reliability of nickel-cadmium communications batteries, and a thorough discussion of the merits of primary, disposable communications batteries. Contact: **Multiplier Industries, Inc.,** 464 South Tenth Ave., Mount Vernon, NY 10550 or R.S. #221.



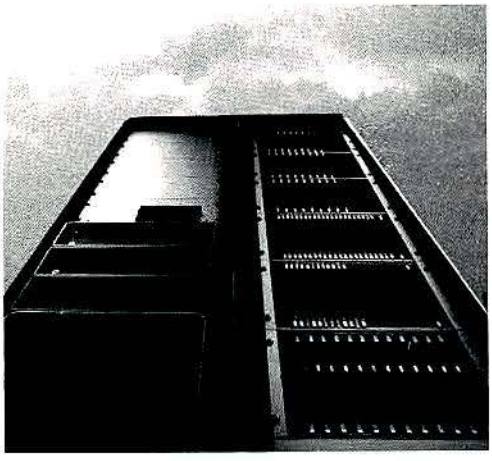
"Would Dr. Jones please raise his hand?"

In your business the answer has to be YES!

If you're involved in radio paging, you know that reliability is perhaps the most important aspect of your system. Glenayre proudly presents the GL RNS3000 combined radio paging and voice retrieval system — we're already leading the way to new industry heights.

Truly the most versatile and reliable system available today or tomorrow! Using pulse code modulation (P.C.M.), together with Winchester hard disk voice storage, the GL RNS3000 ensures the highest voice quality, dynamic range and grade of service. All analog and digital formats — present and future — tone-only, tone and voice, display, mailbox and networking. Glenayre has it all.

The ultimate combination — Glenayre's proven track record in radiotelephone terminals together with the best after sales service in the industry. Can you afford not to investigate this revolutionary system?



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people

CTI Manufacturing Company has promoted **Robert Joiner** to executive vice president and also named him as director of the company. Joiner will be responsible for guidance in all areas of the company's activities with particular emphasis on development in the cellular marketplace. **Thomas D. Keenum, Sr.** was also named a director of the company. Keenum is president of and senior counsel of Keenum & Keenum, P.A. Booneville, Mississippi and is presently active as general counsel and with the Boards of Bench Craft, Inc., and Moss Hill Holdings, Inc.

John Meurling has been appointed to the newly-created position of vice president for investor relations within the Ericsson Group management. Meurling will spend half of his time in the United States, establishing his headquarters at The Ericsson Corporation in New York.

M/A-COM Land Mobile Communications, Inc. has named **James C. Flowers** as director of marketing and sales. Flowers assumes the responsibility for the division's conventional and cellular radio sales.

Reed L. Royalty has been named vice president of external affairs of PacTel Mobile Access, the new cellular mobile telephone subsidiary of Pacific Telesis Group. He will be responsible for governmental, regulatory, business and public relations for the firm, which is headquartered in Costa Mesa, California.

Richardson Electronics has appointed **Richard Ermlovich** area manager for their new office in Orlando, Florida. This office will handle the states of Florida, Georgia and Alabama.

DAY Telecommunications has announced the appointment of **Thomas Lyerly** as vice president of engineering. **Jim Nelson** has joined DAY Telecommunications as vice president of marketing/sales.

RF Monolithics, Inc., (RFM) has appointed **Ron Jones** vice president of manufacturing. He will be responsible for wafer and device manufacturing, corporate purchasing and corporate facilities.

Rocco A. Eramo, of John Eramo & Sons, a construction firm in Columbus, Ohio, has been elected to serve as chairman of the board of the Special Industrial Radio Service Association. Eramo's election came on the eve of the Association's 30th anniversary.

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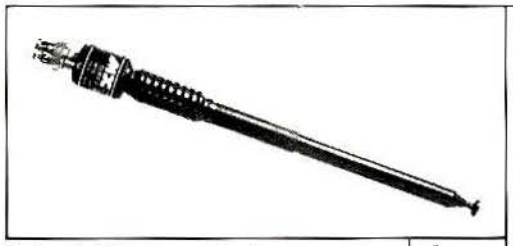

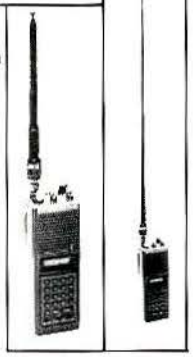

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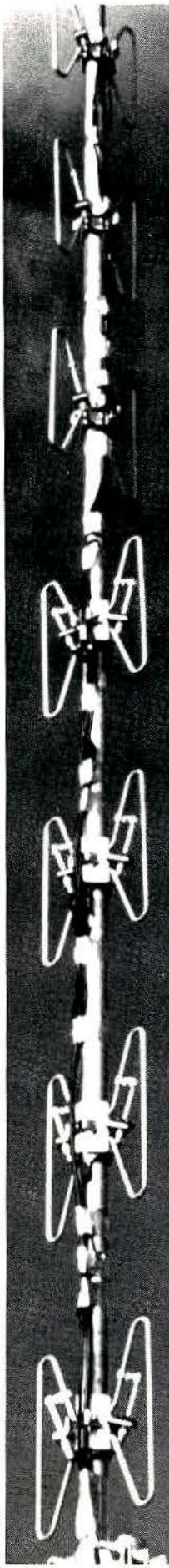

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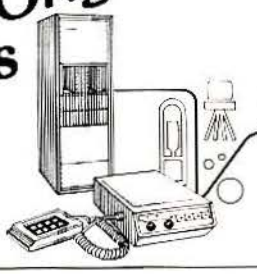

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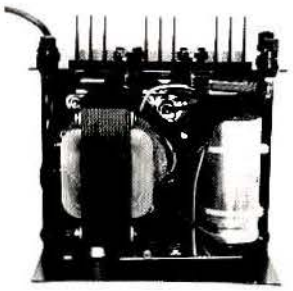

INSIDE VIEW – RS-12A

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MODEL RS-50A

MODEL RS-50M

MODEL VS-50M

RM-A SERIES

MODEL RM-35A

19" x 5¼ RACK MOUNT POWER SUPPLIES

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RM-35A	25	35	5¼ x 19 x 12½	38
RM-50A	37	50	5¼ x 19 x 12½	50

RS-A SERIES

MODEL RS-7A

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W X D	Shipping Wt (lbs)
RS-4A	3	4	3¾ x 6½ x 9	5
RS-7A	5	7	3¾ x 6½ x 9	9
RS-7B	5	7	4 x 7½ x 10¾	10
RS-10A	7.5	10	4 x 7½ x 10¾	11
RS-12A	9	12	4½ x 8 x 9	13
RS-20A	16	20	5 x 9 x 10½	18
RS-35A	25	35	5 x 11 x 11	27
RS-50A	37	50	6 x 13¾ x 11	46

RS-M SERIES

MODEL RS-35M

- Switchable volt and Amp meter

MODEL	Continuous Duty (Amps)	ICS* (Amps)	Size (IN) H x W x D	Shipping Wt (lbs)
RS-12M	9	12	4½ x 8 x 9	13
RS-20M	16	20	5 x 9 x 10½	18
RS-35M	25	35	5 x 11 x 11	27
RS-50M	37	50	6 x 13¾ x 11	46

VS-M SERIES

MODEL VS-20M

- Seperate Volt and Amp Meters
- Output Voltage adjustable from 2-15 volts
- Current limit adjustable from 1.5 amps to Full Load

MODEL	Continuous Duty (Amps) @13.8VDC@10VDC@5VDC	ICS* (Amps) @13.8V	Size (IN) H x W x D	Shipping Wt (lbs)
VS-20M	16 9 4	20	5 x 9 x 10½	20
VS-35M	25 15 7	35	5 x 11 x 11	29
VS-50M	37 22 10	50	6 x 13¾ x 11	46

RS-S SERIES

MODEL RS-12S

- Built in speaker

MODEL	Continous Duty (Amps)	ICS* Amps	Size (IN) H x W x D	Shipping Wt (lbs)
RS-7S	5	7	4 x 7½ x 10¾	10
RS-10S	7.5	10	4 x 7½ x 10¾	12
RS-10L (For LTR)	7.5	10	4 x 9 x 13	13
RS-12S	9	12	4½ x 8 x 9	13
RS-20S	16	20	5 x 9 x 10½	18

*ICS—Intermittent Communication Service (50% Duty Cycle 5 min. on 5 min. off)

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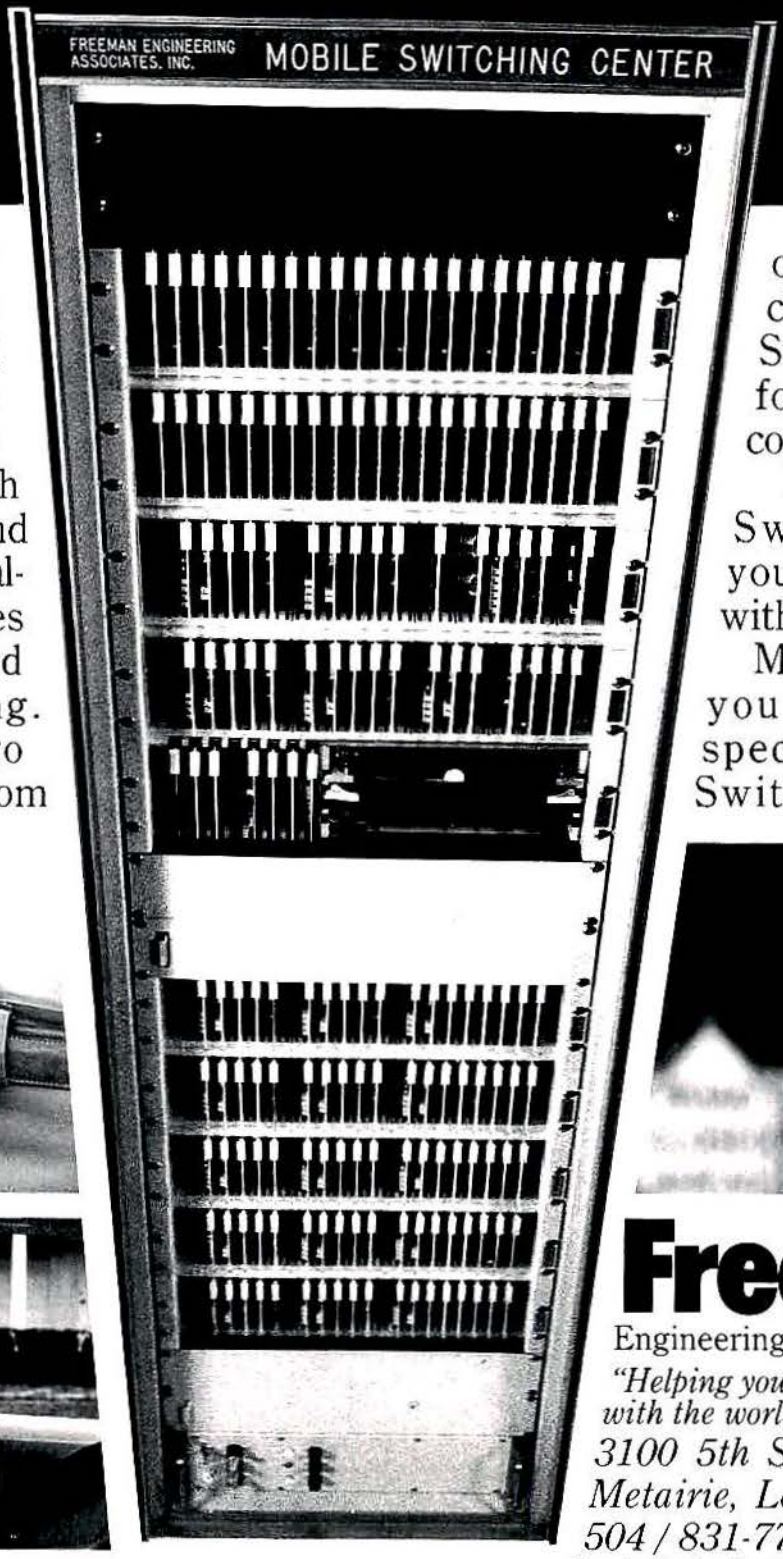

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